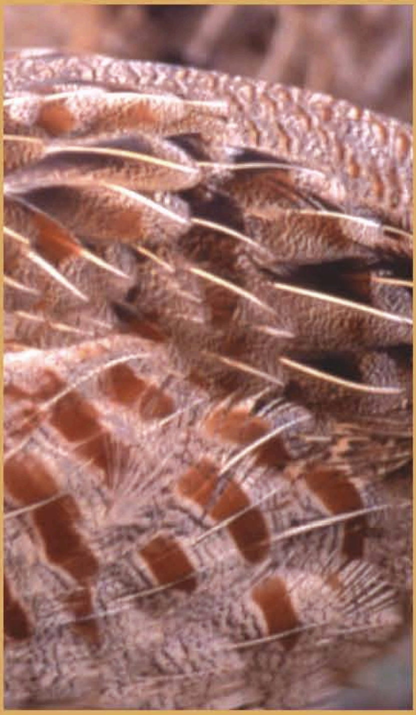
Review

of 2003



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

www.gct.org.uk

THE GAME CONSERVANCY TRUST

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Review of 2003

Issue 35

A full report of the activities of The Game Conservancy Trust (Registered Charity No. 279968) and of Game Conservancy Limited during the year

www.gct.org.uk

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The Game Conservancy Trust's Objects

The Trust is registered with the Charity Commission (Registered Charity No. 279968):

- to promote for the public benefit the conservation and study of game species, their habitats and the other species associated with those habitats;
- to conduct research into the ecology and biology of game species and their environmental requirements and to publish the useful results of such research;
- to advance the education of the public in game biology and in the conservation of game (especially, but not exclusively, in the conservation of game as a sustainable resource).

Corporate sponsorship

The Game Conservancy Trust acknowledges the exceptional support of its Corporate Sponsors in 2003, Hiscox, RP Hodson incorporating John Wimble Insurance Brokers and International Motors Limited, in assisting vital research and educational work to conserve game, wildlife and their habitats in Britain.

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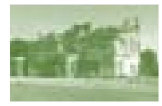
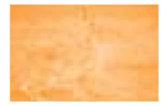
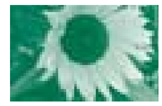
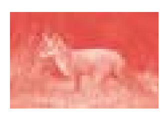
THE GAME CONSERVANCY TRUST

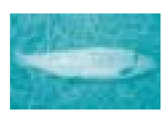
Contents











The Game Conservancy Trust Council

as at 1 January 2004

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	A Hogg

Chairman's report

2003 proved to be a difficult fundraising year for the Trust and it is very disappointing to have to report a financial deficit of £290,379. Many of the reasons for this are set out in the Financial Report for 2003 on page 6 and, although our costs were on budget, we failed to reach our income targets. To address this we took a major decision to restructure the organisation with the appointment of a professional Head of Fundraising. Edward Hay was appointed in December and joined the Trust in January 2004 after 13 successful years as fundraiser for Macmillan Cancer Relief. It is perhaps surprising that a charity of our size has taken so long to appoint a full-time fundraiser and I believe this will bring a much needed professionalism to all our fundraising activities.

There have been many positive developments during the year. I am hugely encouraged by the ability of the Trust to influence policy and the announcement of Entry Level Stewardship is a great reflection of our research and expertise in the agri-environmental field over many years.

The research of The Game Conservancy Trust shows that management for game is a genuine force for good in the countryside, and that field sports (hunting, shooting, fishing) contribute substantially to the conservation of landscape, habitat and wildlife. In this way field sports represent a living example of *conservation through wise use* - a key concept for sustaining biodiversity through the 21st century.

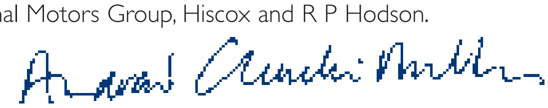
To this end, during the year we sought to develop our influence with a series of political dinners. At Westminster, thanks to the support of John Gummer MP, we have held three all-party dinners which proved both useful and informative. We also held a similar event in Edinburgh with all-party representation. We plan to continue with this programme in 2004 to inform and advise politicians about the value of game management in the wider context of wildlife management. I would particularly like to thank Jim Paice, MP for South East Cambridgeshire and now a Trustee, for the time and trouble he takes to involve himself in the Trust's issues as well as giving us the benefit of his political guidance.

Two of our flagship projects - the Upland Predation Experiment (see page 36) and Grey Partridge Recovery Project (see page 56) - have produced exciting results during the year. Wader numbers continue to recover strongly on our keepered areas on Otterburn and we were even able to facilitate three day's grouse shooting (including a driven day). Our June Council meeting was held at Otterburn in 2003 enabling Trustees to see and hear first hand about the progress being made. Royston has also recorded a 76% increase in the number of grey partridge pairs, which gives us encouragement that we can meet our Biodiversity Action Plan targets by 2010. We now have over 1,500 farms and estates in our Grey Partridge Count Scheme, which is believed to be unique in Europe.

2003 saw the first meeting of our reconstituted Scientific Advisory Committee (SAC) under the chairmanship of Professor Chris Perrins of Oxford University. This distinguished group provides independent scrutiny of our research programme and thus confidence to our membership and those outside our organisation about the integrity and validity of our science.

We continue to liaise with many organisations. In particular, I would mention our now annual meeting at chairman, chief executive and chief scientist level with the RSPB. This year we invited them to Loddington for a full day of discussion and information exchange. We also hosted a similar delegation from BASC at Fordingbridge and were able to update them on our various research projects. Such meetings are vitally important in creating better understanding and goodwill.

Once again I would like to thank Teresa Dent, Dr Nick Sotherton, the other directors and all our staff for their dedication and professionalism. They command the respect of politicians, civil servants, other non-governmental organisations as well as our members and supporters. We are also grateful for the continuing support of our corporate sponsors: International Motors Group, Hiscox and R P Hodson.



Key achievements

- The Trust's reputation for scientific excellence has grown among MPs and decision makers.
- The Trust's techniques were adopted more widely by countryside managers and appeared within agri-environment schemes.
- The flagship projects made excellent progress during 2003.
- The Trust's Scientific Advisory Committee was reinstated.

Andrew Christie-Miller

Paul Quagliana

Financial report for 2003

Summary and key points

- Expenditure on charitable objects increased by 13.7% in the year as planned.
- Income failed to reach targets, resulting in a deficit in the General Fund of £188,497.
- Overall deficit of £290,379 in the year, compared with a surplus of £324,570 in 2002, reflecting income received in advance for project expenditure.

The summarised accounts for the year ended 31 December 2003, set out on pages 8 and 9, 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 and its wholly-owned subsidiary Game Conservancy Limited. The full annual accounts, which were approved by the Trustees on 22 April 2004, 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.

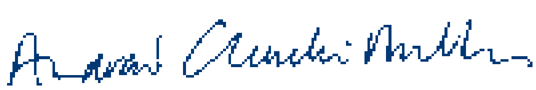
2003 was a mixed year for the Trust financially. On the plus side, the income was maintained at very nearly the level achieved in 2002, which had itself been a record year and included an exceptional grant of £200,000 and a legacy of £85,593. As planned, the Trust spent a record amount on its charitable objects (£3,371,955); its direct research expenditure exceeded £2 million; and it almost doubled the amount it spent on conservation projects to £394,051, as a result of starting a major new habitat restoration project on the River Monnow largely funded by Defra. Charitable expenditure was 62% of total expenditure.

Although high by the Trust's historic standards, the income was nevertheless rather less than had been budgeted, mainly because the income from fundraising activities such as the Ball, sponsorship, the raffle and County Committee events was less than expected. This led to a deficit of £188,497 on the General Fund. The timing of a legacy budgeted for 2003, but actually received in 2002 further exacerbated the overall position, and there was therefore an overall deficit of £290,379. The experiences of 2003 have led to the development of a revised budget process and the restructuring of the fundraising department.

The deficit is reflected in the Balance Sheet where the net current assets have reduced from £946,275 to £549,096, including a reduction of £262,424 in the cash balances (net of overdrafts which are included in creditors). It is anticipated that the Trust will have to draw down on its investments during 2004, partly to fund the proposed property improvements (for which restricted funds have already been received).

As mentioned in the 2002 Report, the Trust changed its investment managers during 2003 and the investment policy was also changed so that the objective is now to achieve double the return on cash. The new managers completely restructured the portfolio in the light of this policy, and exposure to UK equities was substantially reduced in favour of both international equities and, in particular, international bonds. The portfolio produced total returns of -5% in the first three months of the year under the old managers and +8% in the remaining nine months under the new managers. This compares with a return of 3% on cash in this second period, in which the objective was therefore achieved.

The Trustees have agreed that the General Fund Reserve should ideally be six months' General Fund expenditure plus the amount used to finance fixed assets. This compares with the actual level of about two months' expenditure. Although the Trustees are satisfied that the Trust's financial position remains reasonably secure, they consider that it is a priority to rebuild the Trust's reserves over the next few years.



A W M Christie-Miller
Chairman of the Trustees

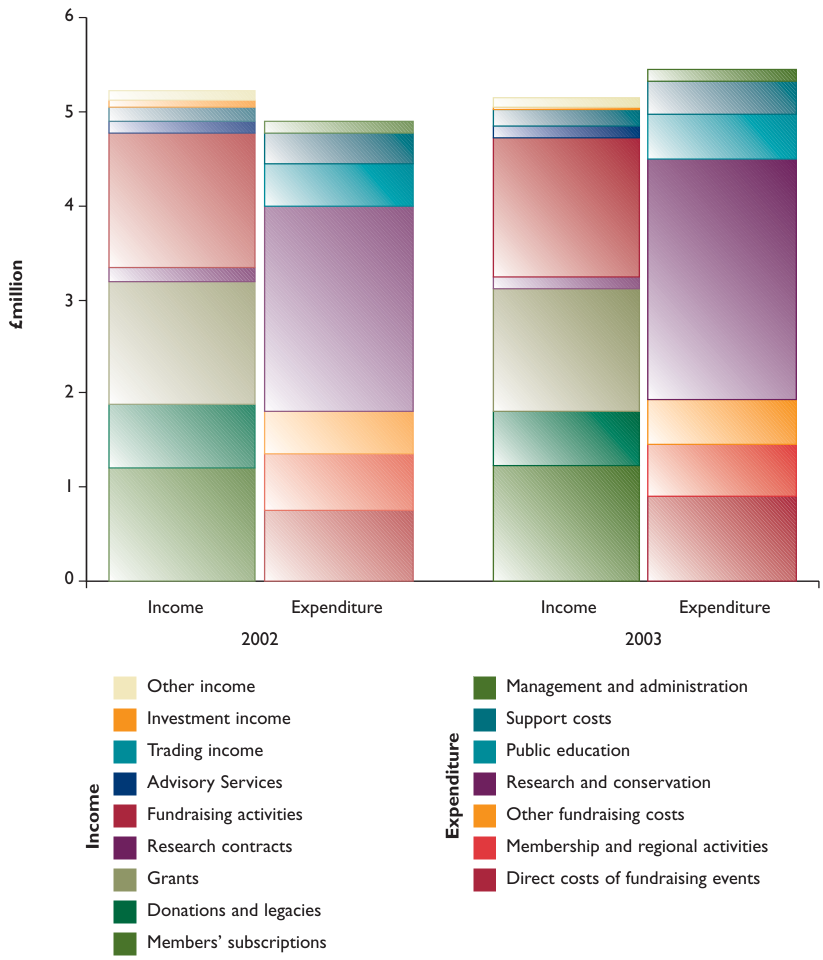


Figure 1

Incoming and outgoing resources in 2003 (and 2002) 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 8 and 9.

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 2003.

FLETCHER & PARTNERS
Chartered Accountants and Registered Auditors
Salisbury, 29 April 2004

consolidated

Statement of financial activities

for the year ended 31 December 2003

	Unrestricted funds General Fund £	Unrestricted funds Designated Funds £	Restricted Funds £	**Total 2003 £**	Total 2002 £
INCOME AND EXPENDITURE					
INCOMING RESOURCES					
Voluntary income					
Members' subscriptions	1,220,385	-	-	**1,220,385**	1,199,103
Donations and legacies	182,972	1,921	411,471	**596,364**	681,970
Grants	96,859	-	1,198,088	**1,294,947**	1,303,100
	1,500,216	1,921	1,609,559	**3,111,696**	3,184,173
Furtherance of charitable objects					
Research contracts	132,271	-	-	**132,271**	149,402
Activities for generating funds					
Fundraising events	1,482,588	-	4,444	**1,487,032**	1,442,754
Advisory Service	121,827	-	-	**121,827**	120,508
Trading income	165,290	-	-	**165,290**	149,079
Investment income	39,479	-	-	**39,479**	64,603
Other income	53,527	-	40,875	**94,402**	102,980
TOTAL INCOMING RESOURCES	3,495,198	1,921	1,654,878	**5,151,997**	5,213,499
RESOURCES EXPENDED					
Costs of generating funds					
Direct costs of fundraising events	907,819	-	-	**907,819**	764,391
Membership and regional activities	554,394	2,219	-	**556,613**	584,516
Other fundraising costs	409,460	1,902	65,798	**477,160**	448,756
	1,871,673	4,121	65,798	**1,941,592**	1,797,663
Activities in furtherance of the charity's objects					
Lowlands research	661,894	5,858	803,122	**1,470,874**	1,295,339
Uplands research	360,639	2,746	325,353	**688,738**	686,401
	1,022,533	8,604	1,128,475	**2,159,612**	1,981,740
Conservation	65,198	1,571	327,282	**394,051**	216,531
Public education	418,489	1,886	52,700	**473,075**	445,289
Support costs	234,898	1,376	108,943	**345,217**	322,318
	1,741,118	13,437	1,617,400	**3,371,955**	2,965,878
Management and administration	127,904	925	-	**128,829**	125,388
TOTAL RESOURCES EXPENDED	3,740,695	18,483	1,683,198	**5,442,376**	4,888,929
Net incoming/(outgoing) resources before transfers	(245,497)	(16,562)	(28,320)	**(290,379)**	324,570
Transfers between funds	57,000	(57,000)	-	**-**	-
NET INCOMING/(OUTGOING) RESOURCES	(188,497)	(73,562)	(28,320)	**(290,379)**	324,570
OTHER RECOGNISED GAINS AND LOSSES					
Realised losses on investments	(37,005)	-	-	**(37,005)**	(22,488)
Unrealised gains/(losses) on investments	57,744	-	-	**57,744**	(241,989)
NET MOVEMENT IN FUNDS	(167,758)	(73,562)	(28,320)	**(269,640)**	60,093
BALANCES AT 1 JANUARY 2003	1,451,384	321,993	898,252	**2,671,629**	2,611,536
BALANCES AT 31 DECEMBER 2003	£1,283,626	£248,431	£869,932	**£2,401,989**	£2,671,629

consolidated

Balance sheet

at 31 December 2003

		2003		2002
	£	£	£	£
FIXED ASSETS				
Tangible assets		670,683		588,684
Investments		1,384,253		1,373,911
		2,054,936		1,962,595
CURRENT ASSETS				
Stock	23,627		37,745	
Debtors	666,526		777,508	
Cash at bank and in hand	586,048		651,423	
	1,276,201		1,466,676	
CREDITORS:				
Amounts falling due within one year	727,105		520,401	
NET CURRENT ASSETS		549,096		946,275
TOTAL ASSETS LESS CURRENT LIABILITIES		2,604,032		2,908,870
CREDITORS:				
Amounts falling due after more than one year				
Life membership subscriptions	158,719		177,389	
Finance lease obligations	43,324		59,852	
		202,043		237,241
NET ASSETS		£2,401,989		£2,671,629
Representing:				
INCOME FUNDS				
Restricted funds		869,932		898,252
Unrestricted funds:				
Property refurbishment fund	91,761		91,761	
Other designated funds	156,670		230,232	
Total designated funds	248,431		321,993	
General fund	1,307,047		1,477,152	
Non-charitable trading fund	(23,421)		(25,768)	
		1,532,057		1,773,377
TOTAL FUNDS		£2,401,989		£2,671,629

Approved by the Trustees on 22 April 2004 and signed on their behalf

ANDREW CHRISTIE-MILLER
Chairman of the Trustees

Chief Executive's report

Key achievements

- An excellent year for research with key results coming through.
- Game management and conservation increasingly providing general wildlife management solutions.

Teresa Dent

Welcome to our new style *Annual Review*.

Although it has been a difficult year for fundraising, it has been an excellent year for research. Some very important results emerged in 2003, and can be read about in detail in the pages that follow.

The game management and conservation package needs to be seen as an intrinsic and beneficial part of a wider wildlife management strategy. It increasingly provides general wildlife management solutions. After all, game management must represent the largest type of wildlife management that takes place in the countryside. Recent examples include the fact that our predator control work has created a new mink detection and control mechanism - the GCT Mink Raft (see page 88), which we expect to be a great benefit to water vole conservation. The interest shown in this new technique by wildlife conservation organisations is huge.

Work done in 2003 confirmed the difficulty farmland birds have in finding enough food through the indirect effects of pesticides (see page 18). Again game management provides a solution; our survey (page 58) shows that 93% of lowland shooting estates put out food that is accessible to songbirds as well as to game.

Previous research continues to have an influence. The 'Cereals and Gamebirds Research Project', through which the Trust invented conservation headlands, managed field margins and beetle banks started in the 1980s under Nick Sotherton. The project aimed to change the practice of game managers; it has become research that has enormously influenced policy. So much so, that these prescriptions (and many researched since) have been incorporated into all agri-environment schemes to date and, from 2005, into the new Entry Level Stewardship Scheme.

The game management world should be proud that their game conservation techniques are proving to be so beneficial to other wildlife.

A glance at this new-style *Review* will prove how hard we are working to provide a scientific basis for game and wildlife management. This simply could not happen without the support of our members, of grant-giving charitable trusts and other research funders, and of the many land and riparian owners who permit us access to their land for our work. My thanks go to all of them, and in full measure to all the staff, directors and trustees for their hard work, commitment and enthusiasm.

MP Ben Bradshaw visited our stand at the CLA Game Fair in 2003 where he learnt about black grouse from Teresa Dent. (Louise Shervington)

Public relations in 2003

Our public relations strategy in 2003 aimed to increase our public profile so that our research is better known and becomes part of main-stream conservation.

We promote our work through the media, always ensuring that we are presented as an authoritative organisation with a sound science base. We need to be taken seriously, seen as independent of government, not representing a particular interest group, but as a body working for better game and wildlife management. To speak with authority we should not simply jump on any environmental band wagon to make a quick sensation. Our science reputation is paramount and we will always challenge those who try to undermine it. Over the last five years our press coverage has increased over three-fold and last year Morag Walker and Katrina Candy, our press officers, aided by Louise Shervington, achieved an all-time record (see Figure 1).

Turning our research into conservation now depends as much on influencing policy-makers as it does on advising landowners. With much land now subject to conservation designations and to an increasing range of agri-environment schemes, we need to ensure that policy decisions made by Defra and other statutory agencies set standards that are not detrimental to wildlife, and that they grant-aid measures that we know are realistic and will work. In the past we have had significant success in persuading the government to modify its set-aside rules and in providing new options under Countryside Stewardship for arable farms. We were very pleased that during 2003 we were able to work with Defra to develop a range of wildlife-friendly options for the new Entry Level Stewardship Scheme and for the revised Countryside Stewardship for 2005. We regularly meet government and conservation agency officials at all levels to brief them on our work, and we have an expanding list of members of the English and Scottish parliaments whom we brief regularly on topical conservation matters.

Science needs to be understandable – especially to our members. Although it is clearly fundamental that our work is published in the scientific literature, few people have the time or the inclination to read research papers. To this end, Sophia Miles, who edits our publications, has re-designed our Annual Review. Shorter stories; far less text; and, on the premise that a picture is worth a thousand words, bigger and clearer illustrations. We hope you like it.

Key achievements

- Record achieved for amount of press coverage.
- Range of options for agri-environment schemes developed with Defra.
- Increasing influence on government and officials thanks to independent objective research.
- Expanding range of publications designed to be easily accessible, readable and useful.

Stephen Tapper

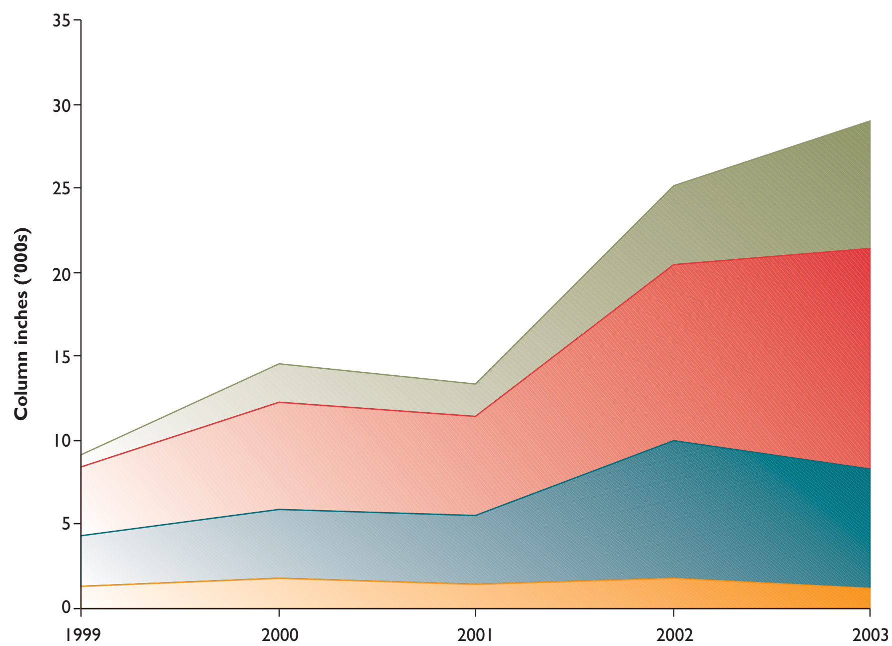


Figure 1

Press coverage over the last five years expressed as number of column inches broken down by category

- General
- Sporting
- Local press
- Nationals

Note: although the graph shows printed press coverage of the Trust, it does not take into account air-time on radio and TV, which also reached an all-time high in 2003

Advisory Services in 2003

Key achievements

- Our core business, consultancy visits and training courses, grew again to generate an income 16.4% above budget.
- We appointed a new Advisor/Biodiversity Officer for the vacant but very important North of England region.
- The Ernest Cook Trust awarded our Advisory Services a substantial grant to deliver discounted advice and demonstrations on the management of the three Biodiversity Action Plan species for which The Game Conservancy Trust is the Government's lead or joint lead partner, namely grey partridge, black grouse and brown hare.

Ian McCall

Delivering game conservation

Demand for on-site advice grew in 2003 on 2002 levels even though 2002 demand was inflated owing to Foot and Mouth Disease the previous year. One reason for this growth was that interest in managing land for game and other wildlife continues to escalate, as do Government grants available to finance habitat enhancement. The second reason is that the removal of Emtryl (Dimetridazole) from game feeds prompted many shoots that rely on stocking to get help on re-siting and expanding release facilities. Thirdly, some of our new services, in particular testing red grouse and mountain hares for louping ill, proved popular, especially north of the Border.

New man in the North

The search to fill our vacant North of England Regional Advisor post finally paid off when we secured Mike McKendry for the role. Mike will also be the Biodiversity Officer in the North of England allowing Peter Thompson to focus on the south. A further success delayed the start of Mike's training for this role: our North of England upland research team won a Heritage Lottery Fund grant to prepare a funding bid for a North Northumberland Black Grouse Recovery Project. With his experience as a qualified land agent for the MoD's Otterburn Ranges, Mike was uniquely qualified to undertake this task. It will also make him especially well-qualified to advise on black grouse once he reverts to his consultancy, biodiversity and regional roles.

The Ernest Cook Award

In April 2003 our application for funding to provide farmers and land managers with subsidised assistance for improvements to benefit grey partridges, black grouse or brown hares within the UK succeeded. By June we conducted the first discounted on-site advisory visit and prepared a series of demonstrations to raise awareness of the opportunities and funding available for these Biodiversity Action Plan species. The Ernest Cook Trust only awards one-off grants, and the popularity of this scheme is such that we are already looking for further funding to extend it. We are anxious to hear from a potential future funding source, be it a charitable trust, or even a land management company with commercial interests and a commitment to the BAP principle.

Education

Our two major public education events in 2003 were Countryside Live (London) and The Game Conservancy Scottish Fair (Perthshire). Both grew in stature and popularity in 2003.

We also continued to support The Countryside Foundation for Education and The Royal Highland Educational Trust with technical information and staff time. In response to members' requests, Katrina Candy developed simple educational 'field signs' in preparation for new access legislation. Available from our Sales Centre, these identify and explain habitat prescriptions and ask for minimal disturbance of them in key periods such as the nesting and chick-rearing seasons.

Mike McKendry (left) was recruited in 2003 as our Biodiversity Officer in the north, which enables Peter Thompson (centre) to concentrate on the south. Mike is also an Advisor, joining the team which includes Mike Swan (right). (Sophia Miles)

Courses

Our residential courses for aspiring and experienced keepers remained very popular, as did the Fur, Feather, Fin (Young Shots) course in Perthshire and Wise Ways with Conservation course at Fordingbridge. Similarly, an increased repertoire of regional Fish and Game Management Days attracted great support and interest, especially our part-time keepers' day in Angus and the day near Chichester on maximizing the potential of a mixed shoot.

On that note, congratulations to longstanding Advisory Services clients, Ian and Claire Smith, on their well-earned first prize in the prestigious 2003 Purdey Game and Conservation Awards for their Nether Hale farm shoot in Kent. They have already kindly agreed to 'open their doors' for a game management day in 2004 so others can see and be inspired by this success, which so ably demonstrates our 'conservation through wise use' principle.

Research Director's Report

The Research Department of The Game Conservancy Trust takes great pleasure in presenting the findings of our scientific activities during 2003. During the year, 94 staff worked in the Department including 24 post-doctoral researchers, four gamekeepers and nine PhD students associated with eight universities in England, Scotland and the USA. As a group, we published over 30 papers in the scientific press including three from our research students successfully defending their theses and being awarded PhDs.

We have changed the format of the *Review of 2003* to present our science in way that is more concise and readable. However, the painstaking detail of the research still goes on. In 2003, our research priorities remained very similar to those reported in previous years and indeed it seems clear that they are unlikely to change in the short to medium term.

Our priorities are based on the challenges and issues that face the game management community. Successfully achieving the Biodiversity Action Plan (BAP) targets for the species for which we are responsible, ensuring the highest standards of management for reared game to ensure rearing remains a force for good in the British countryside and quantifying the consequences of gamekeepering to the wider countryside and its wildlife all remain at the top of our agenda.

2003 was a warm, dry, breeding season, the like of which we have not seen in 20 years. In the majority of cases wild game, especially grey partridges, thrived but if we are to achieve our BAP targets we need to rely on the Trust's science-based management, ably demonstrated at our Grey Partridge Recovery Programme (see page 56), and not on the weather alone.

Our research on reared birds is beginning to deliver fascinating insights into how they interact with their environments (see page 72) and how we can approach this vexed question of density.

Finally, we are making excellent progress with our Upland Predation Experiment (see page 36), Loddington (see page 24) and with our GIS project (see pages 40 and 58) as their output begins to reveal convincingly the value of good keepering.

Key achievements

- Grey partridge demonstration project shows that BAP targets are achievable.
- Upland predation project is beginning to show that predator control is helping ground-nesting birds.
- Mapping moorland managed for grouse and game crops planted for shooting across the UK shows, for the first time, the extent of beneficial habitats provided in the name of shooting.
- Research on the effect of pheasant release pens shows that careful siting can ensure damage to sensitive woodland is avoided.

Nick Sotherton

Our research is designed to be practical so that our members can apply its findings on their land. (Malcolm Brockless)

Farmland ecology summary for 2003

Key achievements

- Completion of the Indirect Effects of Pesticides project, which has determined the importance of insect chick-food in summer and seed in winter for the survival and breeding success of farmland birds.
- Completion and final analysis of data for our survey of brown hares and grey partridges, on behalf of Defra, on pilot Arable Stewardship Scheme farms in the West Midlands and East Anglia.

John Holland

The results from the Government's study examining the environmental impact of genetically modified (herbicide-tolerant) crops came as no great surprise to us. Our research has highlighted the importance of weeds as the base of the farmland food chain supporting many invertebrates and providing food for other wildlife - especially birds. Farming practice that eliminates weeds will reduce the abundance and diversity of farmland wildlife.

This year we began a collaborative project reviewing the wider biodiversity issues associated with pesticide use. This will greatly help those responsible for pesticide registration to ensure that wildlife is thoroughly protected. The results of our project on the indirect effects of pesticides (see page 18) will also provide crucial data for this work. Food for farmland birds has undergone a long-term reduction, shown by our Sussex study and at Loddington.

We are studying how insects and birds are distributed across farmland, especially in relation to the non-crop habitats in a number of our projects. We will use this to provide advice on which habitats should be protected from farm inputs or where new habitats should be located for most effect. Our work on farming and wildlife is consequently broad-ranging, but our underlying aim is to provide advice that will be practical.

Much of our farmland research focuses on the whole food chain as this is what affects farmland wildlife including game species. (Laurie Campbell)

Farmland research in 2003

Project title	Description	Staff	Funding source	Date
Sussex study - chick food	*Monitoring chick-food availability in cereals over the Sussex Downs*	*Nicholas Aebischer, Steve Moreby*	*Core funds*	*1970 - on-going*
3D farming	*Using field margin management techniques to increase beneficial insect numbers and diversity on farmland*	*John Holland, Sue Southway, Matt Begbie, Tom Birkett, Heather Oaten, Rhian Leigh, Chris Andrews*	*Defra, SEERAD, Dow AgroSciences, HGCA, HDC, PGRO, Tesco, Unilever, United Agriproducts, GCT donations, The Chadacre Trust, The Dulverton Trust, The Manydown Company, The Worshipful Company of Farmers, The Yorkshire Agricultural Society*	*1999-2004*
Sustainable arable farming for an improved environment (SAFFIE)	*Development of within-crop and margin practices that will enhance farmland biodiversity*	*John Holland, Sue Southway, Barbara Smith, Tim Bray, Tom Birkett*	*Defra, SEERAD and EN through Sustainable arable LINK programme, HGCA, Syngenta, BPC, CPA, RSPB, LEAF, Sainsbury's, Safeway, National Trust*	*2002-2007*
Indirect effects of pesticides (see page 18)	*Determining whether availability of chick-food in summer or seed in winter is controlling survival and breeding success of farmland birds*	*John Holland, Sue Southway, Barbara Smith, Tom Birkett*	*Defra*	*1999-2004*
Enhancing chick-food in set-aside	*Comparison of chick invertebrate food availability in minor crops*	*John Holland, Steve Moreby*	*Core funds*	*2001 - on-going*
Invertebrate monitoring of Loddington Estate	*Long-term monitoring of invertebrates in all fields in the study area*	*Steve Moreby, Sue Southway*	*ARET*	*1992 - on-going*
Invertebrate monitoring of partridge restoration project	*Extensive monitoring of invertebrates in all fields in the study area*	*John Holland, Tim Bray*	*Core funding*	*2002 - on-going*
Individual-based predator-prey spatio-temporal dynamics	*Examination of predatory beetle and cereal aphid spatial dynamics using laser-marked beetles*	*John Holland*	*BBSRC Plymouth University, RR, Syngenta*	*2002-2005*
Pesticide risk assessment	*Development of a scheme for the assessment of risks to wider biodiversity arising from the use of pesticides*	*John Holland Staff from Rothamstead Research and Centre for Agri-environment Research*	*Defra,*	*2003-2004*
PhD: hedgerows	*Comparing survival in and attractiveness of different field boundaries to beneficial insects*	*Georgiana Griffiths (Supervisors: John Holland, GCT and Dr L Winder, Plymouth University)*	*Plymouth University Core funds*	*1999-2003*
PhD: beetles	*Examining the nutritional quality of invertebrates consumed by beetles*	*Sarah Oakes (Supervisors: John Holland, GCT and Dr L Winder, Plymouth University)*	*Plymouth University*	*2000-2003*
PhD: Bio-control in vegetable crops	*Developing conservation bio-control for outdoor vegetable crops*	*Harprit Chhokar (Supervisors: John Holland, GCT and Dr S Leather, Imperial)*	*Imperial College, London Core funds*	*2003-2006*
Analysis of hare numbers	*Analysing regional trends in winter hare numbers based on sighting records from beaglers and harriers*	*Steve Tapper, Jennie Stafford*	*Association of Masters of Beaglers and Harriers*	*2002-2003*
Arable Stewardship pilot (see page 16)	*Re-survey of grey partridge and brown hare abundance on agreement and non-agreement farms to evaluate pilot Arable Stewardship options*	*Nicholas Aebischer Stephen Browne, Matt Edwards*	*Defra*	*2002-2003*
Game crops and farmland birds (see page 22)	*Use of game crops by songbirds in arable and grassland regions throughout year*	*David Parish*	*SNH, Tesco, John Ellerman Foundation, various CTs*	*2001-2004*
Grassland conservation headlands	*Testing the effects of grass headland management on farmland birds*	*David Parish*	*Scottish Agricultural Colleges*	*2000-2003*

Key: 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; RSPB = Royal Society for the Protection of Birds; SEERAD = Scottish Executive Environment and Rural Affairs Department; SNH = Scottish Natural Heritage; ARET = Allerton Research & Educational Trust; EN = English Nature; Defra = Department of the Environment, Farming and Rural Affairs

Brown hares and grey partridges flourish under Arable Stewardship

Key findings

- Brown hare abundance and grey partridge reproduction improved on farms signed up to the pilot Arable Stewardship Scheme in East Anglia relative to non-agreement farms nearby.
- Densities of brown hares and grey partridges were three times higher on East Anglian farms than West Midlands farms.
- Measures now being extended nationally as part of Entry Level Stewardship, which were trialed in the pilot Arable Stewardship Scheme, should provide a boost to these two Biodiversity Action Plan species.

Stephen Browne

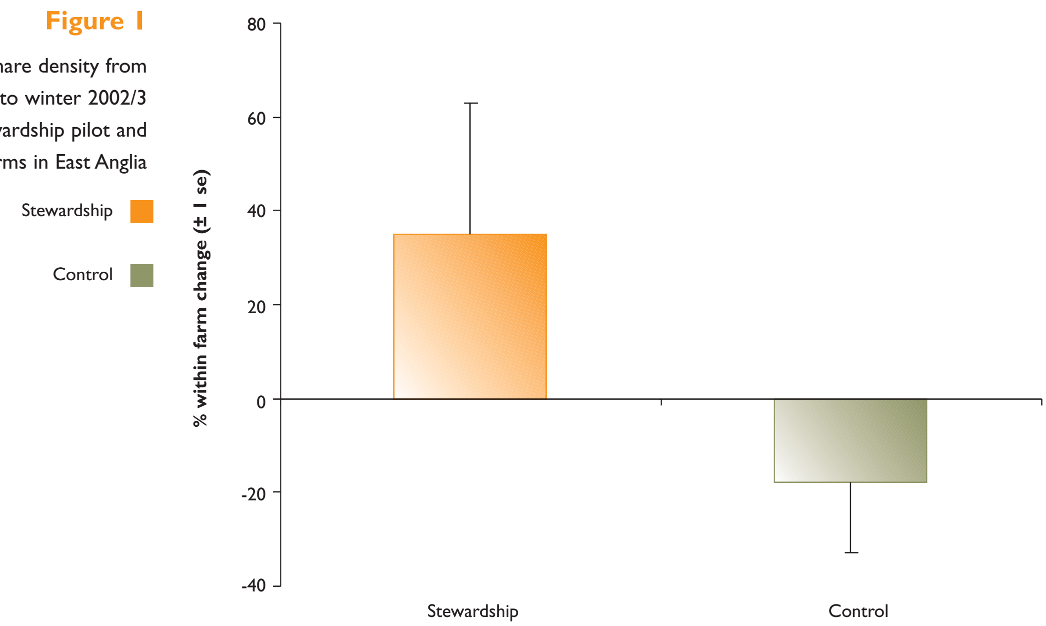
In common with many farmland species the brown hare and the grey partridge have both declined in abundance and distribution over the last 40 years. In recognition of these declines both are now UK Biodiversity Action Plan (BAP) species and as such the Government has undertaken to introduce measures that will halt the decline of the two species and aid their recovery.

Research over many years by the Trust has shown that the decline of both species is linked to the post-war modernisation of agriculture. This research has also suggested a number of management options that may mitigate the negative effects of

The provision of beetle banks (at the left of the picture) and brood-rearing strips (at the right of the picture) are known to help grey partridges and are included within agri-environment schemes. (Stephen Browne)

Figure 1

Change (%) in brown hare density from winter 1998/9 to winter 2002/3 on Arable Stewardship pilot and control farms in East Anglia



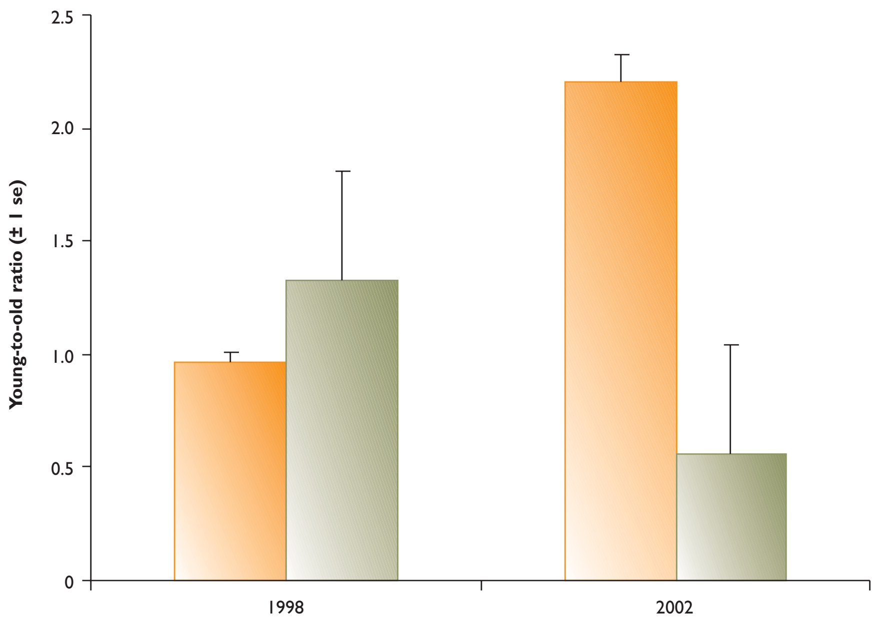


Figure 2

Grey partridge young-to-old ratio in the autumn on Arable Stewardship pilot and control farms in East Anglia

Stewardship

Control

A successful grey partridge nest - the availability of suitable sites has been shown to affect partridge numbers. (Stephen Browne)

intensive farming. Many of these options have been field-tested and shown to enhance brown hare and grey partridge numbers. As a result, many have been included within government-funded agri-environment schemes. The principal one of these is the Countryside Stewardship Scheme, which includes 'Arable Options', which were tried out initially under the pilot Arable Stewardship Scheme.

In 1998 the then Ministry of Agriculture, Fisheries and Food (MAFF) launched the pilot Arable Stewardship Scheme in two areas in England. The aim of this was to test the measures under a range of arable farming systems and conditions. We undertook surveys in 1998/9 and 2002/3 as part of this evaluation, funded by Defra.

In 2002/3, we surveyed brown hares and grey partridges on around 40 pilot Arable Stewardship Scheme farms and around 40 non-agreement farms (used as controls) in East Anglia and the West Midlands, to determine whether the two species benefited from the scheme.

Overall, the densities of both brown hares and grey partridges were at least three times higher in East Anglia than in the West Midlands, which resulted in often much-reduced sample sizes for the latter region. In East Anglia, the relative increase in brown hare density from 1998 to 2002 within each agreement farm (+35%) was significantly better than that within each control farm (-18%) (see Figure 1); in the West Midlands numbers appeared to remain roughly stable on both types of farm. Adult grey partridge densities fell by approximately half from 1998 to 2002 in both regions, with no detectable difference between agreement and non-agreement farms. Grey partridge breeding productivity showed a significant two-fold improvement on agreement farms relative to non-agreement farms over the same period, so that in 2002 the young-to-old ratio was four times higher (see Figure 2) and the average brood double the size on agreement farms than on non-agreement ones. The improved productivity meant that total autumn densities of grey partridges (adults and juveniles) in East Anglia dropped by less (-30%) on agreement farms than on non-agreement farms (-60%). We found no meaningful differences for grey partridges in the West Midlands because of small sample sizes.

These results confirm, at least for East Anglia, that the pilot Arable Stewardship Scheme benefits both the brown hare and the grey partridge. As many of the pilot Arable Stewardship options are now being extended nationally as Arable Options under the Countryside Stewardship Scheme, it is likely that the benefits to these two species will increase as the 'hotspots' become less isolated. If in addition the Arable Options are incorporated into 'Entry Level Stewardship' (formerly known as 'Broad and Shallow'), which is currently under discussion, and are implemented at the landscape scale, we anticipate that they will have a positive effect and provide a major boost to the UK Biodiversity Action Plan for these two species.

Brown hares appear to thrive under Arable Stewardship. (David Mason)

Insecticides reduce food availability for songbirds

Key findings

- Seed used as food for songbirds is in short supply by late winter.
- Late applications of insecticide (late May and June) can eliminate invertebrate food supplies for farmland birds.
- Early insecticide applications are less destructive allowing some recovery.
- There is a relationship between insecticide applications and lower breeding success of farmland birds.
- An insecticide application within 200 metres from a nest site may reduce breeding success by up to 20%.

John Holland

We have shown that the survival of grey partridge chicks depends on an adequate supply of invertebrate food items, many of which in turn depend on weeds. Consequently insecticide and herbicide use can indirectly affect chick survival through removal of their food. Other farmland birds are likely to show a similar response and, so far, this has been proven for the corn bunting. Food supply in winter may also affect bird over-winter survival and subsequent breeding success. Many farmland birds, including gamebirds, feed on weed seeds in winter, and the supply of these depends on weed control in the previous crop and subsequent cultivations. Changes in farming, such as the adoption of GM technology or the introduction of a new pesticide, can consequently have a substantial impact on bird numbers, even though the pesticides are not directly toxic. The Pesticides Safety Directorate of Defra funded this project to look at the indirect effects of pesticides on farmland birds. A major part of the study was a field experiment on three farms in which food supplies in winter and summer were manipulated so that the impact on bird numbers could be measured.

On each farm we set out three experimental plots and one, normally farmed, control. Each plot was 100 hectares. One was provided with extra seed in winter; a second was treated with extra insecticide in summer; and the third had both extra seed and extra insecticide.

These allowed us to look at the effect of more food in winter and reduced (invertebrate) food in summer. Our own entomology staff measured the availability of seed and invertebrates, while staff from the Central Science Laboratory (CSL) counted the birds. The bird counts focused on yellowhammers as this species was the most numerous.

The impact of winter food supplies

We broadcast 36 kilograms per hectare of seeds palatable to songbirds, but small enough to deter pigeons, across the treatment areas three times during the winter. Birds were counted through the winter and the data analysed in two ways. The first

Bird counts focused on yellowhammers as they were the most numerous species present. (Laurie Campbell)

Grasshappers provide an important food source for farmland birds, and are declining rapidly due to loss of habitat and pesticide use. Interestingly they are increasing at Loddington. (David Element)

looked at the short-term response to extra food supplies, and the second examined whether the extra food increased their numbers over the winter. The response varied between farms, but generally chaffinches, linnets and yellowhammers preferred those blocks where extra seed had been spread as was expected from modelled predictions (see Figure 1). However, only yellowhammer density increased through the winter. The abundance of weed seeds also declined through the winter on two of the farms and, although higher at the other, were still too low to attract and hold farmland birds. Most fields had very low densities of weed seed, confirming that this important food source is in short supply as a consequence of modern farming methods.

The impact of summer food supplies

To reduce invertebrate abundance, insecticide inputs were increased by adopting a worst-case scenario for pest infestations so the timings of the applications reproduced what could occur in practice. The number of extra insecticide treatments also varied between the study sites, with the fewest being applied in Hampshire. As each block

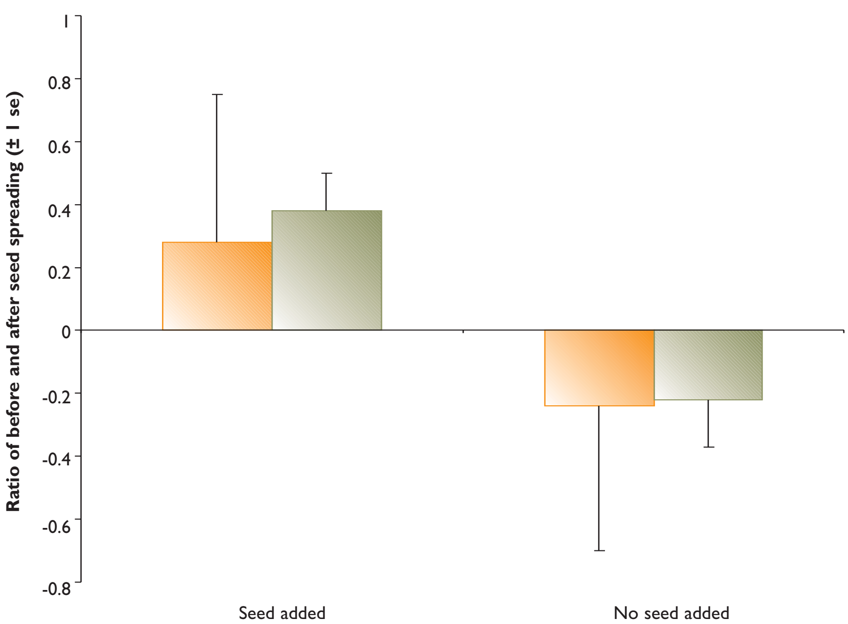


Figure 1

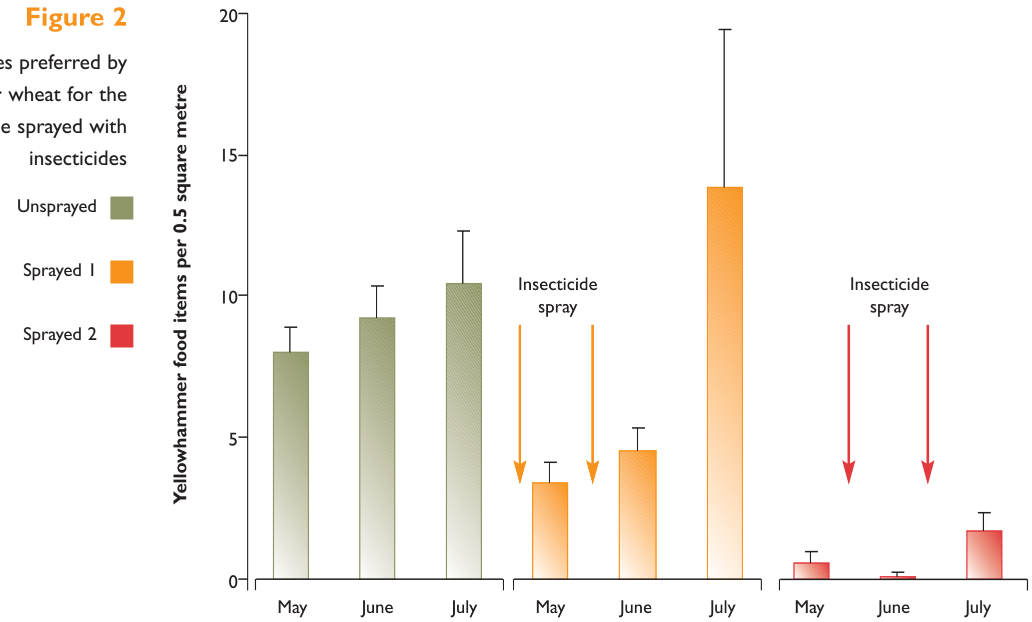
Ratio of numbers of yellowhammer pre- and post-seed application for the two treatments

Observed

Predicted

Figure 2

Density of invertebrates preferred by yellowhammers in winter wheat for the unsprayed fields and for those sprayed with insecticides



contained a range of crops the whole of the treatment blocks were not sprayed at one time and, as a consequence, birds nesting within the blocks always had access to untreated areas. This reduced the effect of the treatment, but was more realistic. The impact of the insecticides on invertebrate abundance and the relative abundance of individual species ('the community composition') varied markedly between the crops. The abundance of those invertebrates most preferred by farmland birds showed considerable variation between the sites. For example, at the Hampshire site, oilseed rape was the most invertebrate-rich crop, whereas spring barley and winter wheat were the poorest. We found that the reverse was true at the Yorkshire site. Similarly, at the Lincolnshire site, spring barley was one of the better crops for invertebrates. The root crops were consistently poor sources of invertebrates. The results indicate that crop management at each site may be the over-riding factor. Looking more closely at each crop we found that if insecticides were applied to winter wheat in early May and June this reduced the yellowhammer food by approximately 50%, but allowed some recovery by July (see Figure 2). Applications in late May and June almost eliminated invertebrate food supplies. In oilseed rape, insecticides are commonly applied in April, but only four applications were applied in April was there any effect on invertebrates in June and July. The analysis comparing community composition showed that the higher insecticide inputs reduced some invertebrate groups in the winter cereals. However, others (the true bugs and small spiders) were more abundant in the high-insecticide areas. These are highly mobile and may have re-entered the crop after spraying and multiplied in the absence of their predators. For this reason, in oilseed rape the invertebrate groups (comprised mainly of pests and small rove beetles) were higher in number in the areas with greatest insecticide inputs. Similarly in sugar beet, the more mobile invertebrates were more abundant in areas of high insecticide input. We looked at the diet of yellowhammer chicks but found that the insecticide treatments caused no change in the type of invertebrates that they consumed.

Shield bugs are part of a large group of insects which are important in farmland bird diets. (David Element)

Staff from CSL examined whether the insecticide applications were affecting the breeding success of yellowhammers. To achieve this they calculated the proportion of the area sprayed within 20 days from hatching for a 200-metre radius around each nest (which represented a typical foraging range) and compared this with various measures of breeding success. A significant relationship was found between the proportion of the area sprayed and the number of chicks surviving to fledge (see Figure 3). Thus if all the area were sprayed around the nest this would reduce the population growth rate by 20%. They also examined what the population growth rate would be given the current levels of invertebrate food found on the farms. This revealed that to maintain the breeding density of yellowhammers at least three times as many invertebrates would be needed.

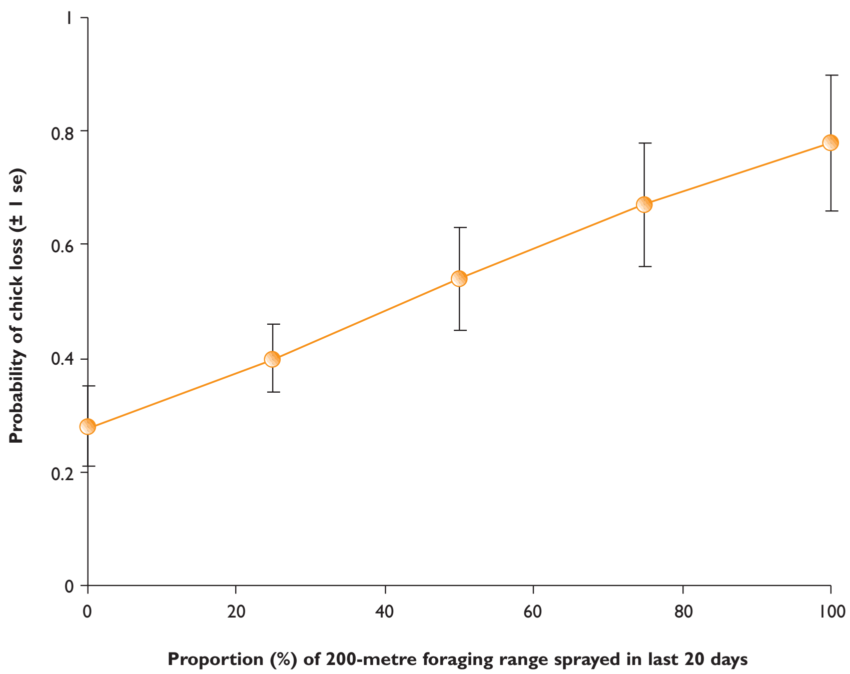


Figure 3

Predicted relationship between the proportion of foraging range sprayed with insecticide and the probability of chick survival being reduced

Other farmland songbird chicks also depend on an adequate supply of invertebrates for their survival and similarly are likely to suffer if this is not available. There is currently no overall indicator that can be used to determine whether sufficient food supplies exist. However, the Trust has developed an index for grey partridge chick food based on our Sussex study. Given that the diet of grey partridge chicks is similar to many farmland songbirds, it provides an indication of food supplies. This also shows that food supplies for grey partridges are typically three times lower than the critical threshold needed to ensure a stable population.

Insecticide applications in May and June almost eliminated invertebrate food supplies. (John Holland)

Songbirds in Scotland prefer game cover crops

Key findings

- In Scotland songbirds are more than 100 times more likely to be found in game crops than arable crops nearby.
- Songbirds are more than 340 times more likely to be found in game crops than grassland crops nearby.
- Mustard and oats attract more songbirds in Scotland than other crops grown as game cover.

David Parish

The decline of farmland songbirds has been well documented and the most popular hypothesis to explain this is that songbird survival rates have declined for most species, owing to a fall in the availability of food on modern farms. Our work on commonly-used game crops has shown that these can be attractive to many bird species across the country. Indeed, our work in eastern Scotland has convincingly demonstrated that up to 100 times more birds are found in game crops than other crops (see Figure 1).

However, one limitation of the research carried out to date is that it refers to arable farming systems, which are typical of much of eastern and southern Britain. This meant that for the 65% or so of agricultural land that is in one form of grassland or another, mostly concentrated in the north and west of Britain, we had no idea of the requirements of farmland songbirds, nor of the role that game crops play on these farms. To tackle this gap in our knowledge, we extended our studies of songbirds and game crops in summer 2003 into the south-west of Scotland, an area typified by intensive grassland management. We visited nine farms approximately monthly from August to December 2003, counting birds in game crops and nearby conventional crops. The game crops were typical of those found across Scotland (kale, triticale, mustard, maize and artichoke), with kale by far the most common (on eight of the nine farms). The conventional cropping encountered, on the other hand, was typical of that found in the region, being mostly grass silage and pasture (grazed and ungrazed), as well as some arable silage (grass mixtures sown with combinations of oats, barley and wheat).

Mustard attracted large numbers of songbirds in our Scottish game crop trials. (Sophia Miles)

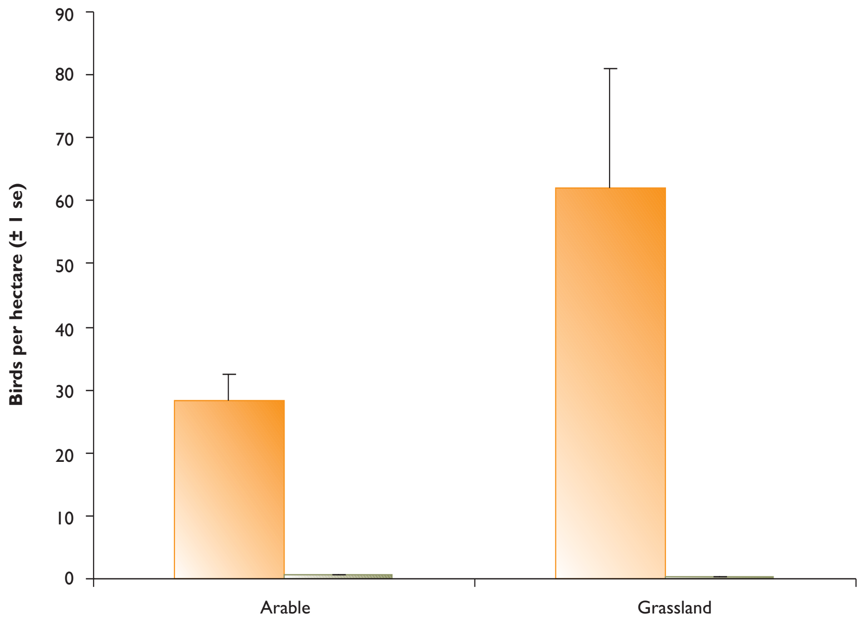


Figure 1

Density of winter birds using game crops on arable and grassland areas compared with other crops

Game crops

Other crops

During the course of the surveys, we saw 19 species of songbirds. We found that all of them used the game crops, but just six used the other crops. Furthermore, the songbirds we saw were on average more than 340 times as abundant in the game crops as elsewhere, with densities averaging over 60 birds per hectare (see Figure 1). This is an enormous difference - far higher than the previous work in eastern Scotland found between game and other crops, where densities in game crops averaged around 30 birds per hectare at the same time of year. This difference between farming systems is perhaps not surprising as it is highly likely that plentiful sources of seeds are far rarer in grassland areas than arable ones, so probably attract birds from a wider area than in arable regions.

Game crops clearly attract large numbers of birds on farms across the agricultural spectrum and probably provide an important food source to them, but one of the important questions to be answered is which specific game crops should be sown? So, in spring 2003 five of the more common and easiest to grow Scottish game crops were sown in replicated blocks in five fields at two farms in Angus, to test the relative use that different species of birds may make of each type of crop. The crops grown were kale, triticale, mustard, oats and linseed. The results of bird counts since October 2003 suggest that mustard and perhaps oats attract more birds than the other crops (see Figure 2). This work complements our project to map the extent of game crops grown in Britain (see page 58).

David Parish within kale grown as a game crop. (The Game Conservancy Trust)

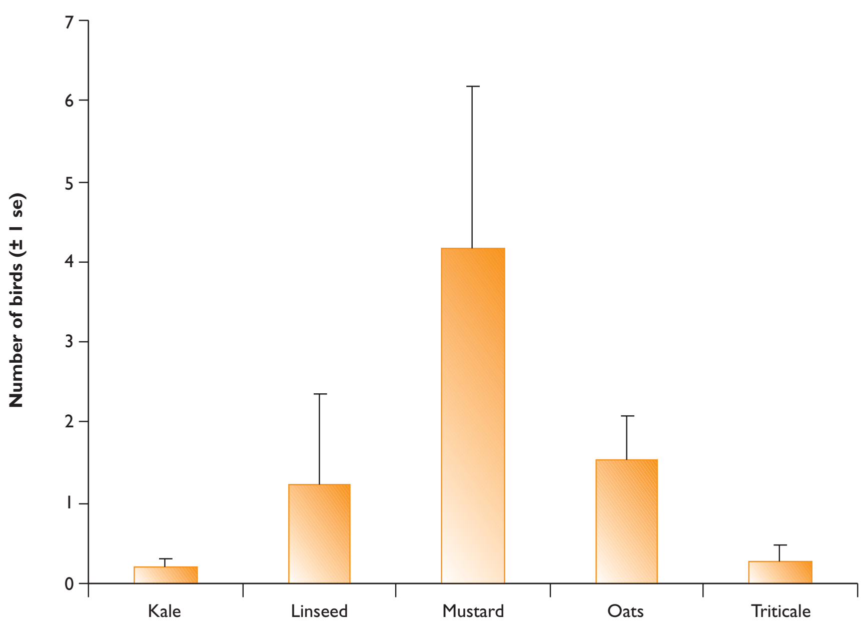


Figure 2

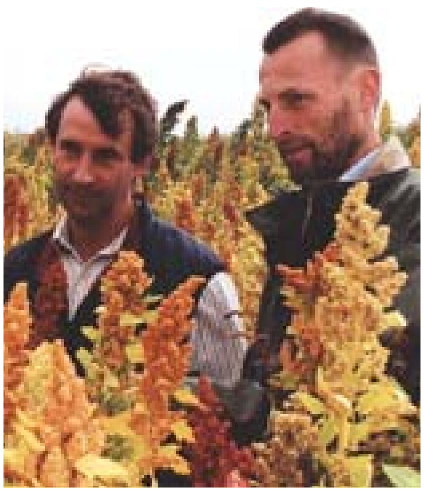
Songbird densities recorded on five common types of Scottish game crops in winter 2003

Loddington summary

Key achievements

- Progress in quantifying the benefit of a gamekeeper.
- Further progress on perfecting seed mixes on set-aside.
- Loddington saw a record number of visitors.
- Two training schemes for farmers and advisors were launched.
- Increased involvement in soil management research and debates.

Alastair Leake



Alastair Leake and Chris Stoate in a strip of quinoa at Loddington. (Louise Shervington)

2003 was the second year of our assessment of the effect of ceasing predator control. When we took over the estate in 1992 we introduced a range of new habitat improvements as well as employing Malcolm Brockless as gamekeeper. The response of the wildlife to this new regime was rapid and dramatic. After 10 years we are now trying to assess the relative importance of predator control as a single activity, against other management practices. This is important work coming at a time when the targets for the UK Biodiversity Action Plan species are starting to loom closer. Many of these targets were set using historical data based on population densities in previous decades when gamekeepers themselves were more common.

To avoid compromising the above, we have tried to make as few changes to our overall farming system as possible. We have, however, continued our experiments on improving seed production from the wildlife seed mixes that we sow on the 20-metre strips of set-aside. This work is important because the land available for such mixes is limited, so it is essential to get maximum value out of every hectare. At the moment we do this by applying inorganic fertilisers and using herbicides, although we have begun to look at clover to supply nitrogen and the use of a mechanical weeder to remove weeds. The work is also important because wildlife seed mixes now feature in the Countryside Stewardship Scheme and this is likely to encourage some farmers and landowners to put them in for the first time. Our experience at Loddington is that, without the right inputs, these strips can look very messy and might deter other farmers from trying them.

In 2003 we had a record number of visitors and we launched several new training initiatives. The Prince of Wales launched our Pathfinders Vocational Training Scheme in January. This is designed for small- to medium-sized farm businesses in the East Midlands and deals largely with environmental management, Entry Level Stewardship, and Countryside Stewardship options. After the launch, the Prince took a private walk across the farm and discussed our work with the Trust's staff. Later in the year we launched a course aimed at agronomists: Biodiversity and Environmental Training for Advisers (BETA) aims to make those advising farmers on the use of pesticides more aware of wildlife and ends with a formal examination and qualification.

Soil management featured highly in our events calendar with training sessions sponsored by the Home Grown Cereals Authority (HGCA) and the UK Soil Management Initiative (SMI). We contributed to a formal conference at the headquarters of the Society of Chemical Industry (SCI) in London and followed this with a practical day in the field with experts joining us from as far as Germany and New Zealand.

Allerton Research & Educational Trust research in 2003

Project title	Description	Staff	Funding source	Date
Effect of predation control (see page 28)	*Effect of ceasing predation control on nesting success and breeding populations of songbirds*	*A Leake. C Stoate, J Szczur, C Watts, K Draycott*	*ARET*	*2001-2004*
Monitoring (see page 28)	*Annual monitoring of game species, songbirds, invertebrates and habitat*	*A Leake, M Brockless, S Moreby, S Southway, C Stoate, K Draycott, B Smith*	*ARET*	*1992 - on-going*
Cultivation trials	*Monitoring ecological, agronomic and economic aspects of different cultivation techniques*	*Alastair Leake Kate Draycott*	*Soil Management Initiative, Vaderstad UK*	*2000 - on-going*
Agronomy for wildlife seed mixes	*Designing a package of inputs to assist farmers to grow wildlife seed mixes*	*Alastair Leake Kate Draycott*	*Tesco*	*2001-2004*
Greys recovery project (see page 56)	*Restoration of grey partridge numbers: a demonstration project*	*A Leake, M Brockless, N Aebischer, S Moreby, S Southway, S Browne, J Ewald*	*Game Conservancy USA, others*	*2001-2006*
PhD: Breeding songbird habitat use	*Foraging behaviour, chick diet and nesting success in relation to invertebrate availability for skylark, yellowhammer and song thrush*	*Kathryn Murray (Supervisors: C Stoate, ARET, A Wilcox, Harper Adams College)*	*Harper Adams University College*	*2000-2003*
PhD: Tillage and soil invertebrates	*The effect of non-inversion tillage on earthworm and invertebrate populations as potential food sources for farmland birds*	*Heidi Cunningham (Supervisors: R Bradbury, K Chaney, A Wilcox, Harper Adams College)*	*Harper Adams University College, Royal Society for the Protection of Birds*	*2000-2003*

Loddington farming year

Total rainfall for 2003 was nothing remarkable, but its pattern was. Spring and summer were uncharacteristically dry, whereas the late autumn rain rapidly saturated our heavy soils and made cultivations impossible. This, along with our mounting black-grass problem, encouraged us to switch from winter to spring beans. Spring cropping on heavy land is somewhat unpredictable and early in the spring as the soil dried out there was concern about the crop. Fortunately the rains came and it developed an impressive stand, yielding over four tonnes per hectare.

Our rape yields averaged three tonnes per hectare, which was disappointing after the large harvest in 2002. Poor establishment and pigeon damage were the main reasons for this, but an average price of £175 per tonne for the rape seed meant that we exceeded our expected crop gross margin. Wheat yielded approximately 7.75 tonnes per hectare and, as world prices have strengthened, we could sell wheat as high as £110 per tonne by the end of the year, although previously we had sold wheat forward at £60 per tonne. Our average price is likely to be £90 per tonne. Fantastic conditions at harvest meant no drying costs and the farm's financial position is decidedly brighter than it looked several years ago. The lamb price has improved and although the dry summer meant grass growth was restricted and more purchased feed was required, the average price of £45 per lamb has given us acceptable returns. Our joint farming operation with Oxey Farm continues to flourish and has spread our machinery costs and reduced our overheads. Because of this we bought a wider range of machinery. Each year we learn something new.

Key results

- Yields up on last year.
- Markets better than in 2002.
- Overheads kept to a minimum.

Alastair Leake

Table 1

Arable crop yields (tonnes/hectare) at Loddington 1994-2003

	1994	1995	1996	1997	1998	1999	2000	2001	2002*	Est 2003
Wheat	7.66	8.61	10.19	7.00	9.34	9.62	8.89	7.25	8.20*	8.35
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
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§
Winter oats	-	-	-	-	-	-	-	-	6.37	7.10
Linseed	0.82	0.93	-	1.16	-	1.36	-	-	-	-

* revised figures; § spring beans

Table 2

Arable gross margins (£/hectare) at Loddington 1994-2003

	1994	1995	1996	1997	1998	1999	2000	2001	2002	Est 2003
Winter wheat	773	1,007	981	551	668	723	572	603	518	794
Winter barley	596	877	802	625	478	534	403	315	328	-
Winter oilseed rape	520	808	868	593	469	468	523	329	611	564
Winter beans	450	626	574	616	507	553	573	331	452	492§
Spring oilseed rape	433	-	-	-	-	-	-	-	-	-
Linseed	473	535	-	497	-	477	-	-	-	-
Winter oats	-	-	-	-	-	-	-	-	462	666
Set-aside	301	331	335	326	296	317	205	204*	251	250

§ spring beans

Table 3

Farm conservation costs at Loddington 2003 (£)

Set-aside *(wild bird cover)*[1]	
(i)Farm operations	1,158
(ii)Seed	1,011
(iii)Sprays and fertiliser	365
Total set-aside costs	**2,534**
Conservation headlands[2]	
(i)Extra cost of sprays	50
(ii)Farm operations	80
(iii)Estimated yield loss	172
Total conservation headlands costs	**302**
Grain for pheasants	1,357
Grass strips	255
Other conservation work	1,204
Total conservation costs	**5,652**
Project-funded seed	(1,011)
Total profit foregone - conservation	**4,641**

[1]Area of wild bird cover = 8.87 ha

[2]Area of conservation headlands = 5.30 ha

Further information on how these costs are calculated is available from the Allerton Research & Educational Trust

Table 4

Farm profit and loss account for the year ending 31 December 2003

	£	
Gross margins		
Arable	155,124	
Sheep	14,303	
Contracting & sundry income	24,717	
Total gross margin		**194,144**
Direct costs		
Labour	43,535	
Implement & vehicle repairs	6,639	
Fuel & oil	10,491	
Vehicle tax & insurance	1,958	
Contract & hire	12,125	
Electricity	941	
Cultivations (valuation change)	3,151	
Total direct costs		**(78,840)**
Gross profit		**115,304**
Overhead costs		
Rent, rates & water	3,623	
Repairs	1,601	
Fencing & hedges	-	
Insurance	2,256	
Sundries	2,020	
Professional fees	3,643	
Administration	3,196	
Total overhead costs		**(16,339)**
Profit before depreciation		**98,965**
Capital costs		
Depreciation	31,611	
Profit on sale of fixed assets	3,673	
Total capital costs: 2002 adjustment		(50,312)
Total profit (loss)		48,653
Profit foregone - research/education/project management	1,926	
Profit foregone - conservation	4,641	
Total profit foregone		**6,567**
Farm profit (loss)		**55,220**

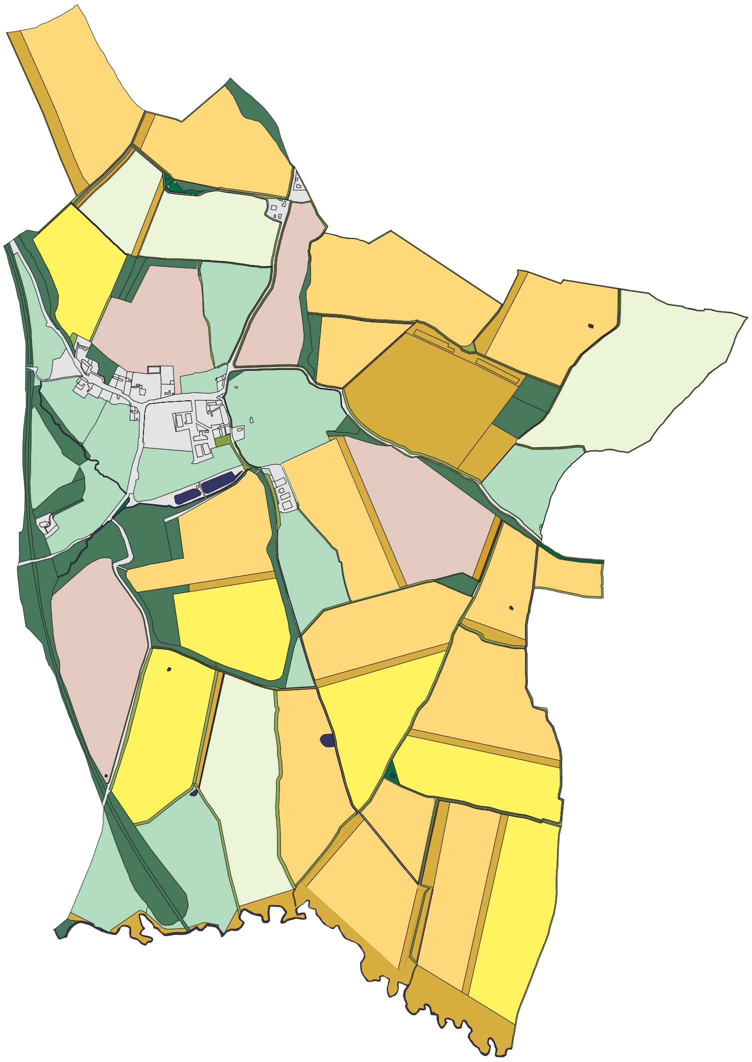


Figure 1

Loddington Estate cropping 2002/3

- Woodland
- Permanent pasture
- Winter wheat
- Winter beans
- Winter oilseed rape
- Winter oats
- Set-aside
- Hedgerow/verge

Lamb prices were good in 2003 giving us acceptable returns. (The Game Conservancy Trust)

Loddington game and songbird counts

Key findings

- Numbers of pheasants, red-legged partridges and hares have dropped since predator control ceased.
- Songbird numbers show signs of decline.
- We fed twice as much grain in 2003 as in 2002.
- Nesting success was as high in 2003 as previously.
- Magpies are still low in number at Loddington.

Chris Stoate

Our work at Loddington places special emphasis on the role of predator control in delivering conservation objectives. Our game counts have shown that autumn numbers of pheasants have declined by 65% since we stopped predator control two years ago (see Figure 1), as have numbers of brown hares (see Figure 2). Red-legged partridge numbers show no obvious trend (see Figure 3).

Songbirds are counted in the spring when they establish breeding territories. If numbers are influenced principally by nesting success the previous year, then following the cessation of predator control, we would have expected a year's delay before seeing any decline in numbers. However, our count suggests that numbers may have started to decline even before this (see Figure 4).

We have tried to retain all the game management operations other than predator control as in previous years. However, we have found that some, such as growing game crops and winter feeding, are more difficult without a gamekeeper. We have been feeding twice as much grain during the last two winters as before when

Figure 1

Pheasant numbers in autumn at Loddington

Young

Cocks

Hens

Predator control in place

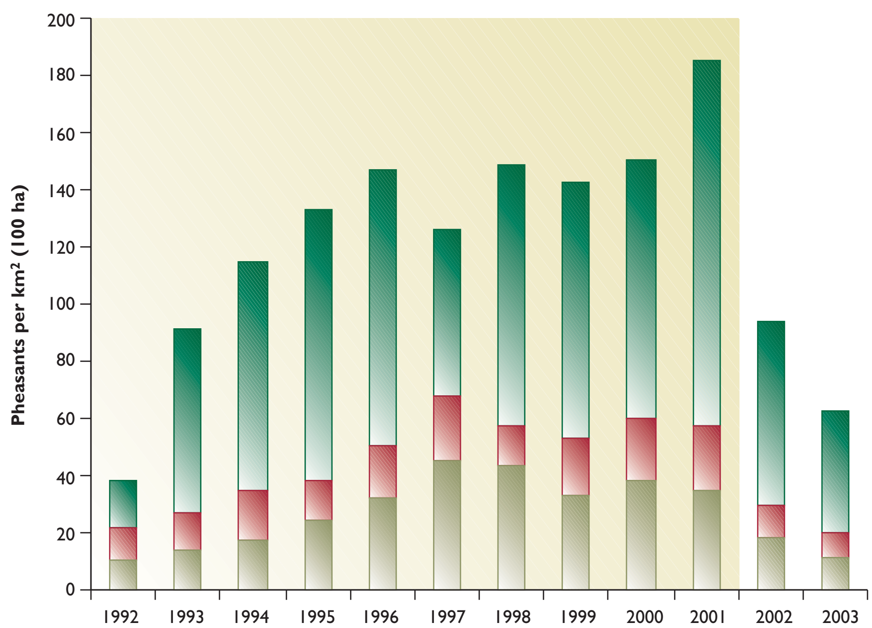


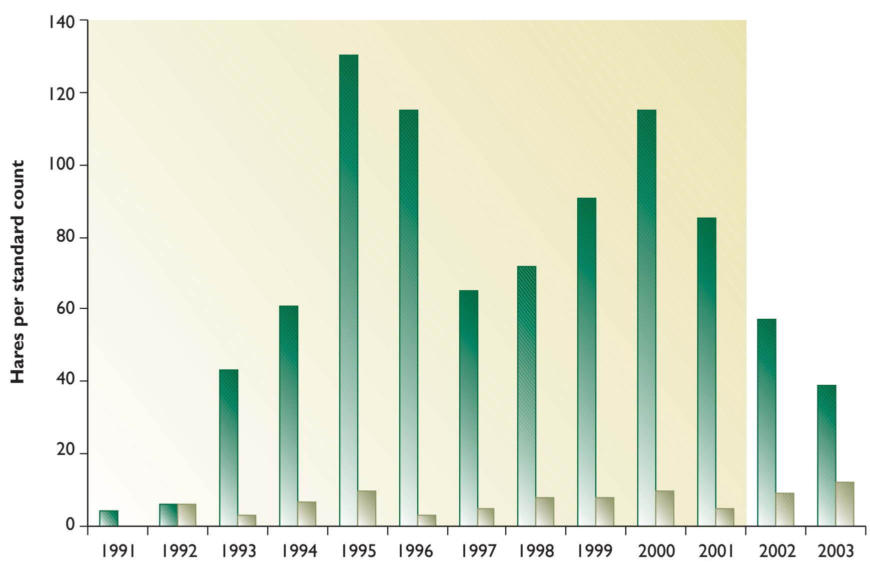
Figure 2

Hare numbers in winter

Loddington

Comparison site

Predator control in place



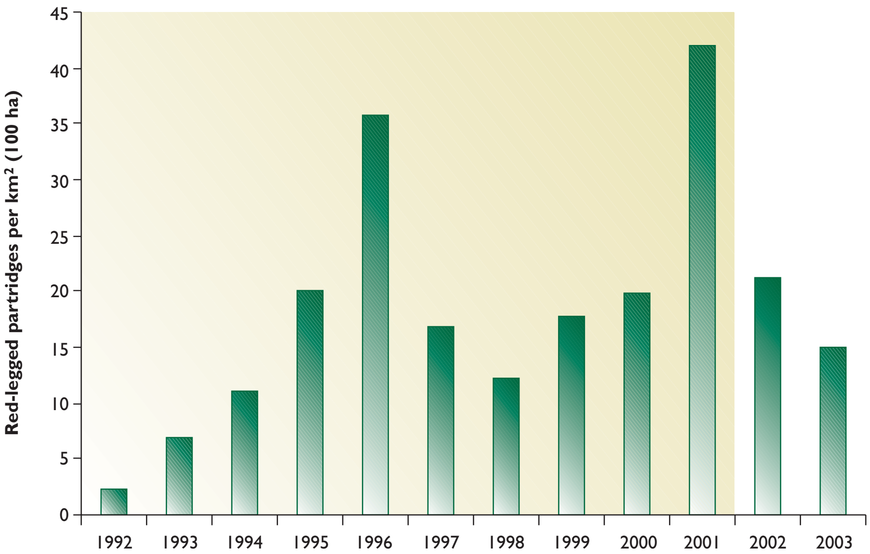


Figure 3

Red-legged partridge numbers in autumn at Loddington

Predator control in place

Note: There have been no grey partridges at Loddington since 2000

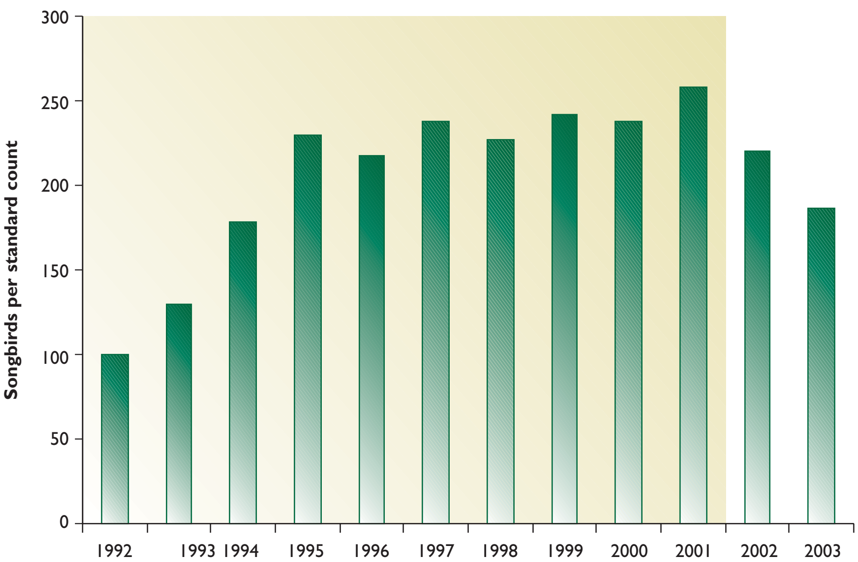


Figure 4

Abundance of nationally-declining songbird species at Loddington

Predator control in place

Nesting success of song thrushes remains good despite the removal of our keeper at Loddington. (Laurie Campbell)

pheasant numbers were considerably higher. It seems that rat and rook numbers are now higher than when our keeper was present, and that these species are eating the grain faster than we can refill the hoppers. Similarly, a keeper can keep an eye on the growth of game crops and take care of them, so that yield is not affected. In fact, providing winter food for birds, in the absence of predator control, could actually be encouraging nest predators such as rats!

Nesting success of whitethroat, a species that escapes nest predation by nesting in grassy field boundary vegetation, has been just as high in the past two years as it was in earlier years. More surprisingly, for species such as song thrush, blackbird and chaffinch (which are susceptible to nest predation), there is little obvious sign of a reduction in nesting success. We need data over more years before a clear trend can be determined. However, the fact that there is currently no large increase in predation may be due to the low numbers of magpies. Before game management started in 1992, there were 10 pairs on the farm; in 2002 and 2003 there were just five and four pairs respectively. This may be because magpies are not as abundant locally as they used to be, noting that some neighbouring farms now undertake magpie control.

Upland ecology summary for 2003

Key achievements

- The start of two new projects on: the impact of louping ill on waders; and the effects of disturbance due to new access rights on moorland breeding birds.
- Another year of gamekeeping and vital data gathered in our Upland Wader Experiment.
- Completion of a mountain hare study to explain population cycles.
- Confirmation that strongyle worms have not become resistant to medicated grit.

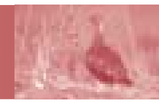
David Baines

David Baines leads our upland research, which is conducted from two main bases: one in Teesdale, County Durham, the other in Strathspey. In 2003 our efforts were dedicated to three main areas. Firstly, we looked at diseases of red grouse. Adam Smith and Alan Kirby have been considering the impact of ticks on grouse chicks and finding ways to combat the effects on grouse of the tick-borne disease, louping ill, in multi-host systems involving mountain hares, sheep and red deer. In England, David Newborn has been testing new forms of medicated grit, which use a stearate fat instead of palm oil and may provide greater persistence of the drug in the grit. This may keep strongyle worms at bay for longer when ingested by grouse. Laboratory-based studies by our PhD student, Ruth Cox, at Durham University suggest that continued use of medicated grit on grouse moors has not yet led to the development of drug resistance in strongyle worms (see page 48).

The second area of research relates to conservation benefits of grouse moor management. This year saw Kathy Fletcher take over the running of the Upland Predation Experiment at Otterburn from Andrew Hoodless. Kathy presided over another successful year, with the plots keepered by Craig Jones and Danny Lawson producing significantly better wader breeding success than the unkeepered control plots (see page 36). Grouse did well too, to the extent that we were able to hold shoots on both keepered moors.

The third area of research relates to Biodiversity Action Plan species, black grouse and capercaillie. Pamela Staley, our seasonal keeper in Teesdale, observed improved black grouse breeding success on her keepered areas for the second year running (see page 34). The future looks promising for black grouse in northern England, with numbers the highest for 10 years and the prospect of Philip Warren landing a major funding initiative for the species in North Northumberland. Isla Graham recorded only a modest breeding season for capercaillie in the Scottish Highlands, but the severe decline appears, at the moment at least, to have slowed or even stopped.

Careful management makes moorland into a prime habitat for many of our native breeding birds. (Laurie Campbell)



Upland research in 2003

Project title	Description	Staff	Funding source	Date
Scottish grouse (see page 32)	*Long-term monitoring of red grouse and worm burdens*	*Adam Smith, David Howarth*	*Scottish Trustees, Core funds*	*1985 - on-going*
Grouse productivity	*Effect of grouse chick and maternal diet on grouse productivity*	*Adam Smith, David Howarth, Alan Kirby*	*Scottish Trustees*	*1999-2003*
Woodland grouse - Scotland	*Ecology and management of woodland grouse*	*David Baines, Isla Graham*	*The Dulverton Trust, LIFE, Scottish Natural Heritage*	*1991-2006*
Langholm research (see page 39)	*Monitoring raptors, grouse, voles, pipits, waders and foxes*	*David Baines, Steve Redpath (Centre for Ecology & Hydrology)*	*Core funds*	*1992 - on-going*
Mountain hare ecology (see page 42)	*Effects of parasites on mountain hares*	*Adam Smith, Scott Newey*	*Scottish Trustees*	*2000-2003*
Tick ecology and control	*Ecology of ticks and developing novel tick control methods*	*Adam Smith*	*Scottish Trustees*	*2000-2007*
Hill cattle	*Effect of Highland cattle on heather moors*	*Adam Smith*	*Highland Cattle Society, Howman Trust*	*1998-2004*
PhD: Muirburn	*Behaviour and ecological impacts of heather fires*	*Matt Davis (Supervisors: Adam Smith, GCT; Colin Legg, Edinburgh Univ)*	*NERC, Core funds, Scottish Trustees, Scottish Natural Heritage*	*2002-2004*
North of England grouse (see page 32)	*Long-term monitoring of red grouse and worm burdens*	*David Baines, Dave Newborn*	*Core funds, Gunnerside Estate*	*1980 - on-going*
Louping ill - red grouse (see page 44)	*Disease management in North York Moors*	*Dave Newborn David Baines*	*North York Moors NP, Local moor owners*	*1996-2003*
Strongylosis	*Development of strongylosis control techniques*	*Dave Newborn, D Baines*	*Core funds*	*1980-2005*
North Pennines black grouse recovery	*Black grouse restoration (BAP)*	*Philip Warren*	*MoD, English Nature, RSPB, Northumbrian Water*	*1996-2006*
Cheviot black grouse	*Range expansion of black grouse through translocation*	*David Baines*	*Private donations, Northumberland NP*	*1996-2004*
Grouse moors - other species (see page 30)	*Effect of grouse moor management on other bird species*	*David Baines Kathy Fletcher, Rob Foster, Craig Jones, Danny Lawson*	*Uplands Funding Appeal, Core funds*	*1998-2007*
Cattle grazing	*Role of cattle in reducing invasive grasses*	*David Baines, Dave Newborn*	*Yorks Agricultural Society, Private funds*	*2002-2004*
Louping ill - waders	*Impact of louping ill on breeding waders*	*David Baines, Dave Newborn*	*North York Moors NP, Moorland Association*	*2003-2004*
Human access and wildlife	*Effects of increased access on breeding waders and black grouse*	*David Baines, Kathy Fletcher, Mike Richardson*	*English Nature*	*2003-2004*
PhD: Red grouse populations	*Grouse dispersal and mortality in relation to parasite management*	*Philip Warren (Supervisors: David Baines, GCT; Dr C Thomas, Durham Univ)*	*Core funds,*	*1999-2003*
PhD: Red grouse and strongylosis (see page 48)	*Field and lab-based experiments on impact of anthelmintics*	*Ruth Cox (Supervisors: David Baines, GCT; Dr C Thomas, Durham Univ)*	*Anonymous donors*	*2000-2003*

Key to acronyms: LIFE = European Union Financial Instrument for the Environment; SNH = Scottish Natural Heritage; NERC = Natural Environmental Research Council; MoD = Ministry of Defence; EN = English Nature; RSPB = Royal Society for the Protection of Birds.

Dry summer helps red grouse

Key findings

- Red grouse numbers on the 21 moors we monitor in Scotland remained stable in 2003.
- Red grouse on the 18 moors we monitor in England recorded the second highest count in a decade.
- Dry weather kept the strongyle worm burdens in grouse low.

David Baines

Red grouse monitoring in 2003

Red grouse monitoring on 21 Scottish moors showed that the average numbers of spring pairs (13 per square kilometre or 100 hectares) were not significantly different in 2003 compared with 2002 (14 per square kilometre). As the loss of heather has largely ceased, these data suggest that over the last five years the national population of red grouse in Scotland may have stabilised at about 130,000 spring pairs. This is important as red grouse are now given an 'amber' (medium conservation concern) status. The July production counts in 2003 showed no significant change compared with 2002 (see Figure 1).

On our 18 long-term study plots in England the counts in 2003 were higher than in 2002, and yielded the second highest density in a decade (see Figure 2). This was the result of increased spring densities coupled with an increase in average brood size. Red grouse bag data indicate an average to above-average season for a number of estates. However, success has not been universal. Some estates had disappointing July grouse counts, with fewer breeding pairs, poor brood sizes and a disappointing

Figure 1

Average density of young and adult grouse in July/August using counts from 21 sites in Scotland 1990-2003

Adult

Young

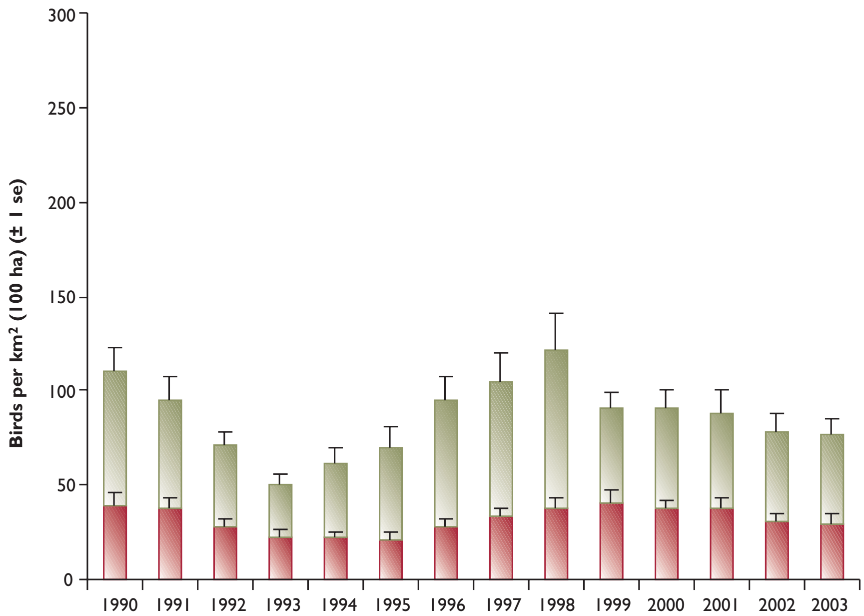
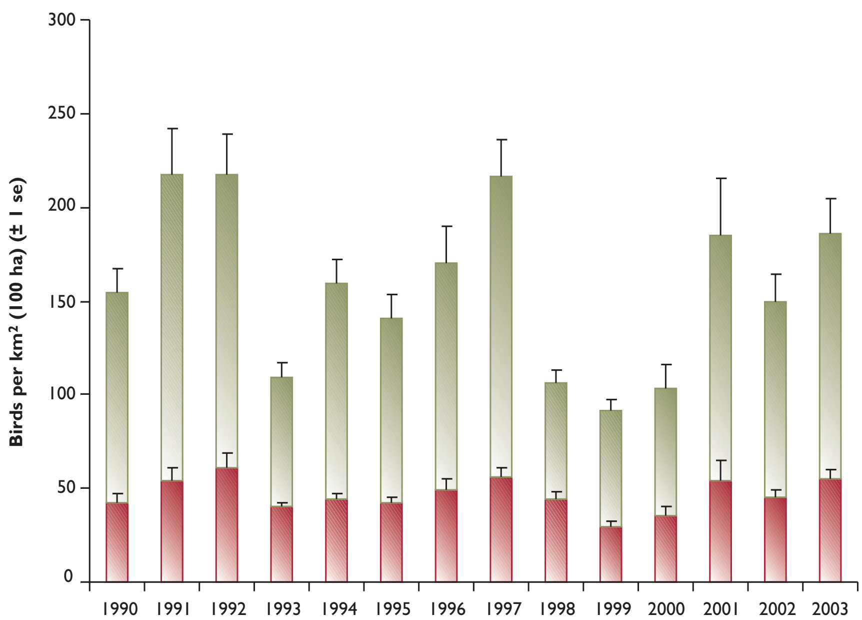


Figure 2

Average density of young and adult grouse in July using counts from 18 sites in England 1990-2003

Adult

Young



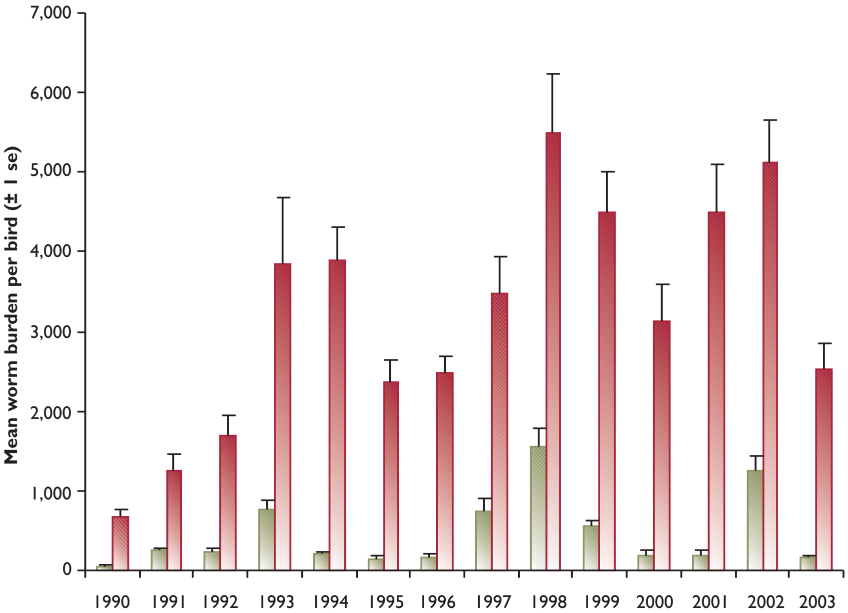


Figure 3

Worm burdens in adult and young red grouse on 10 moors in England (1990-2003)

Adult

Young

David Howarth and Mull counting grouse. (Sophia Miles)

shooting season. This poor performance may have been due in part to the very high worm burdens in some of the autumn grouse populations (see below).

Strongyle worm counts

In contrast to the wet mild summer of 2002, 2003 was one of the driest in recent years. The dry conditions, which started in mid-March, are likely to have reduced the numbers of free-living strongyle larvae. This continued through the autumn. These unfavourable conditions for the free-living strongyle larvae are evident in the worm counts from shot grouse (see Figure 3). With worm burdens in both young and adult grouse below those recorded in 2002, levels in young birds are particularly low indicating fewer strongyle larvae being picked up in the summer and early autumn.

Worm burdens in adult grouse were low in 2003. (Laurie Campbell)

Prospects good for black grouse and capercaillie

Key findings

- Numbers of blackcock attending leks in one Durham dale have been stable over the last 10 years.
- Overall breeding success of black grouse varies between years but shows no trend over time.
- Capercaillie have achieved the number of successful chicks needed for a stable population over the last three years.

David Baines

Black grouse

Our research on black grouse started in 1989, so we now have a reasonable series of data upon which to assess trends in numbers and variations in breeding success. These data are important for assessing conservation programmes such as regional recovery projects. As part of the Scottish Species Action Plan for black grouse we are attempting to collate (with our partners) a national black grouse database that allows us to consider changes in the distribution and abundance of birds not only at national and regional levels, but also in relation to site designation (eg. SSSI) or uptake of agri-environment schemes (eg. ESA).

Perhaps our best data relate to the North Pennines, where counts of blackcock attending leks and brood counts date back to 1989. Numbers of displaying blackcock in one Durham dale from 1990-2003 showed a modest drop in 2003 after increases since 1999 (see Figure 1). The annual breeding success (chicks per hen) for the North Pennines as a whole showed an increase in 2003, although the overall trend remains fairly stable (see Figure 2).

Figure 1

Number of displaying male black grouse in one Durham dale 1990-2003

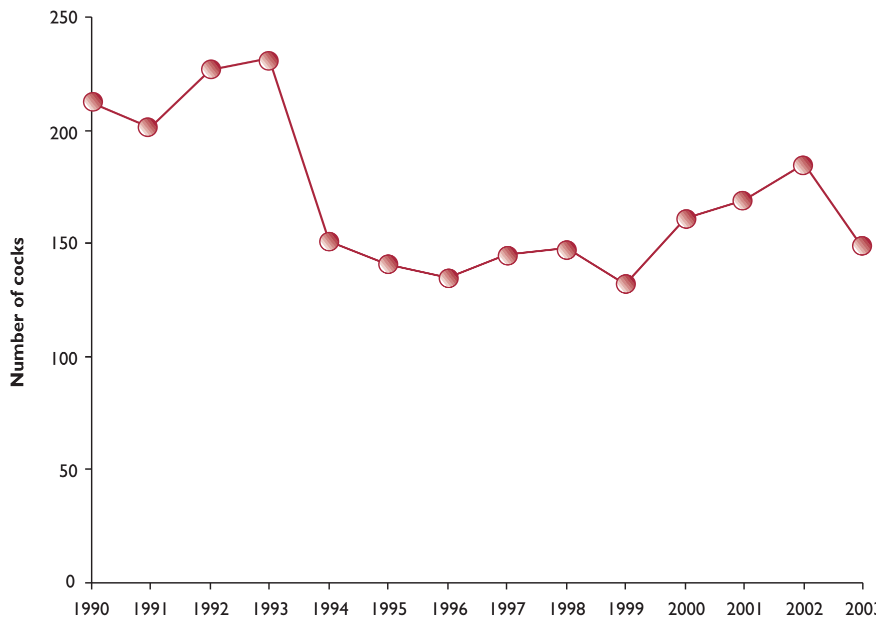
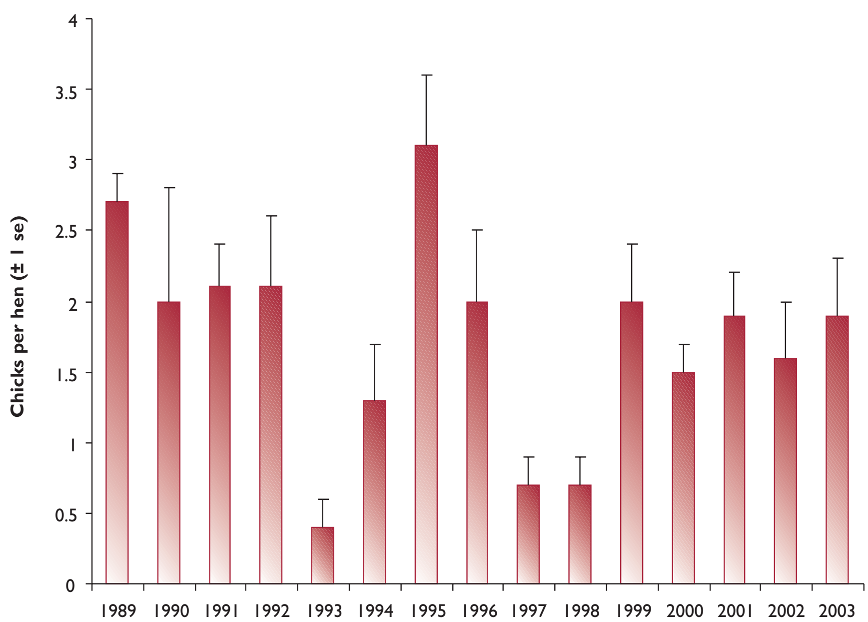


Figure 2

Annual black grouse breeding success (chicks per hen) in the North Pennines 1990-2003



(Laurie Campbell)

Capercaillie

Poor breeding success has been the most important cause of the current decline in capercaillie across their Scottish range. Their poor breeding success is related to higher numbers of predators and changes in spring weather.

Data that we collected in at least 10 forests each year since 1991 show considerable variation between years in the number of chicks reared per hen (see Figure 3). However, in only three of the 13 years of the survey has breeding success exceeded the one chick per hen required to maintain population size. This year the breeding season was only moderate, with an average of 0.9 chicks per hen, but the average over the last three years has been enough to offset adult mortality.

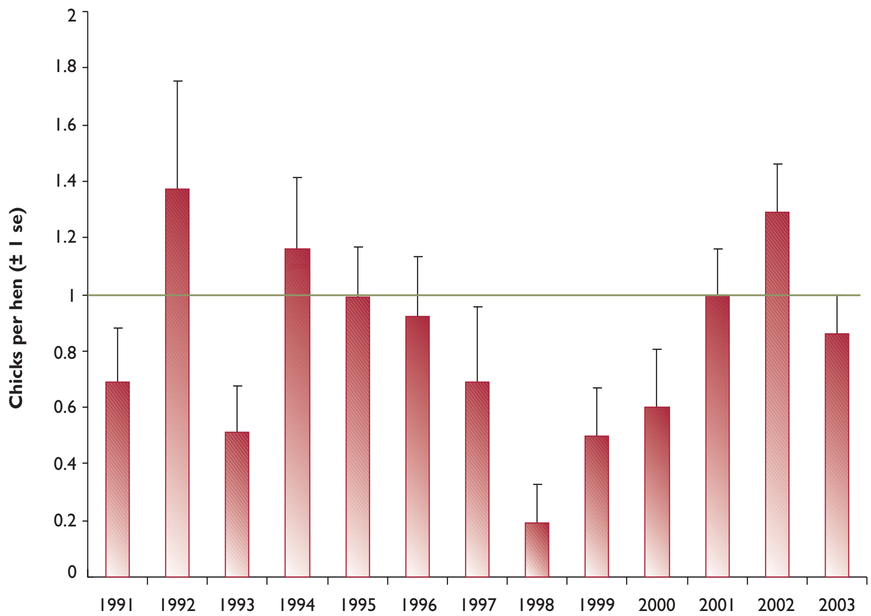


Figure 3

Capercaillie breeding success (chicks per hen) 1991-2003

—— Chicks per hen required to maintain population

Not much stands between the capercaillie and extinction in Britain. (Laurie Campbell)

Does predator control help ground-nesting birds?

Key findings

- Gamekeepers appreciably reduced numbers of main predators on the keepered sites.
- Breeding success of waders has increased on the keepered ground, and for golden plover on the unkeepered ground.
- Breeding success and spring densities of red grouse have risen on the keepered but not on the unkeepered ground.
- These results are preliminary and we can draw no conclusions until the experiment is finished.

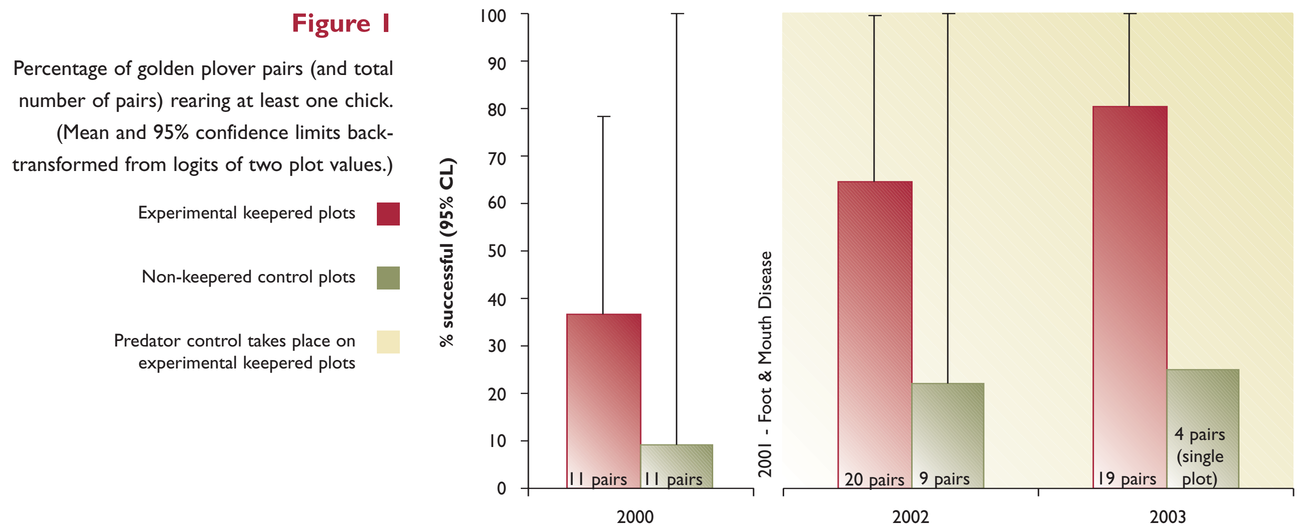
Kathy Fletcher

Predator control can be a controversial management tool, so robust evidence of any benefits is necessary. It is especially important to quantify the effects of predator removal on species of conservation concern such as golden plover, curlew, black grouse and skylark. Our Upland Predation Experiment, which receives funding from the Upland Appeal, is aimed at testing whether predator removal on grouse moors has any effect on the densities or breeding success of a number of moorland bird species. The project is designed to last for eight years and is based on four plots, each about 12 square kilometres (1,200 hectares), which we have monitored since 2000. In the autumn of 2000 we began predator control on two of the plots, Otterburn and Ray Demesne. Nearby Bellshiel and Emblehope remained unkeepered to provide a comparison.

Predator abundance data from 2002 and 2003 illustrate that gamekeepering activities on Otterburn and Ray Demesne have significantly reduced the main fox and corvid predators. Mustelid (stoats and weasels) abundance has not dropped on the keepered plots, despite seven times more animals being culled than in the first year of keepering. Raptor sightings in 2003, particularly of short-eared owls and kestrels, were more frequent than in 2000 on all four of the sites, reflecting a good vole year. Any differences in ground-nesting bird abundance and breeding success observed between keepered and unkeepered areas are unlikely to have been caused by changes in raptor abundance.

Figure 1

Percentage of golden plover pairs (and total number of pairs) rearing at least one chick. (Mean and 95% confidence limits back-transformed from logits of two plot values.)



So far, more curlew pairs have successfully reared chicks on keepered than unkeepered plots. (Laurie Campbell)

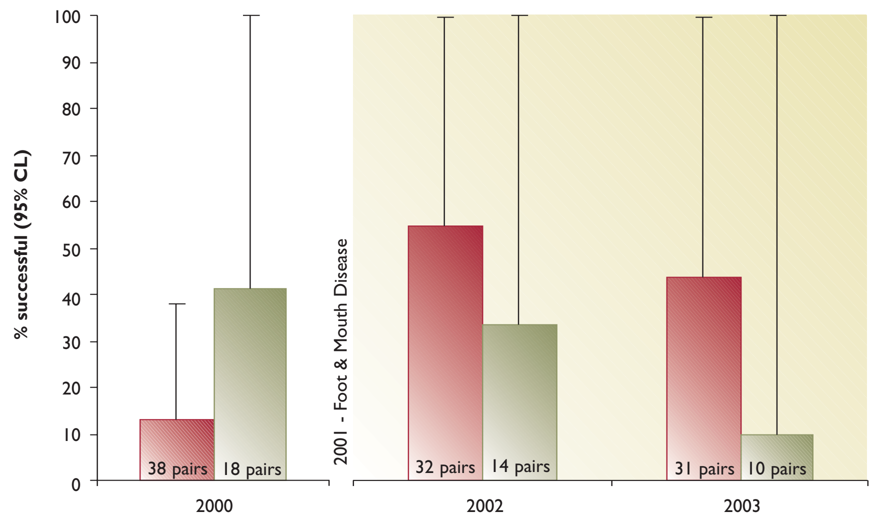


Figure 2

Percentage of curlew pairs (and total number of pairs) rearing at least one chick. (Calculations as for Figure 1.)

Experimental keepered plots

Non-keepered control plots

Predator control takes place on experimental keepered plots

Craig Jones, our head gamekeeper on the project, sets small mammal traps for catching stoats and weasels. (Louise Shervington)

So has the reduction in foxes and crows had any impact on ground-nesting waders? The breeding success for curlew, golden plover and lapwing on the keepered plots was higher in 2003 than before predator removal started on the keepered plots and in contrast there was lower breeding success on the unkeepered areas (see Figures 1-3). There has been an increase in breeding pairs of lapwing and golden plover on the keepered plots and a decline on the unkeepered plots. Meanwhile, curlews showed a decrease in all four areas. At this stage of the experiment, the effect of habitat management and keepering on wader abundance cannot be separated. There is no discernable trend in skylark or meadow pipit densities or breeding success in relation to predator removal.

For red grouse, the trends in spring densities and breeding success are dramatic. In just three years of keepering, the spring densities have more than doubled and July stock increased five-fold so that 2003 produced a shootable surplus. This increase in abundance was driven by better breeding success (see Figure 4 overleaf).

The number of lekking blackcock has increased on the keepered Otterburn plot and dropped on the unkeepered Bellshiel plot, although on both plots numbers are low. Grey partridges are also present in the marginal farmland on the edges of the study areas. The numbers of spring pairs have remained stable on all plots, but brood sizes have doubled on the keepered area with very few broods being seen on the unkeepered area.

To date the trends in abundance and breeding success suggest that predator removal may benefit some of the ground-nesting birds. However, the numbers of

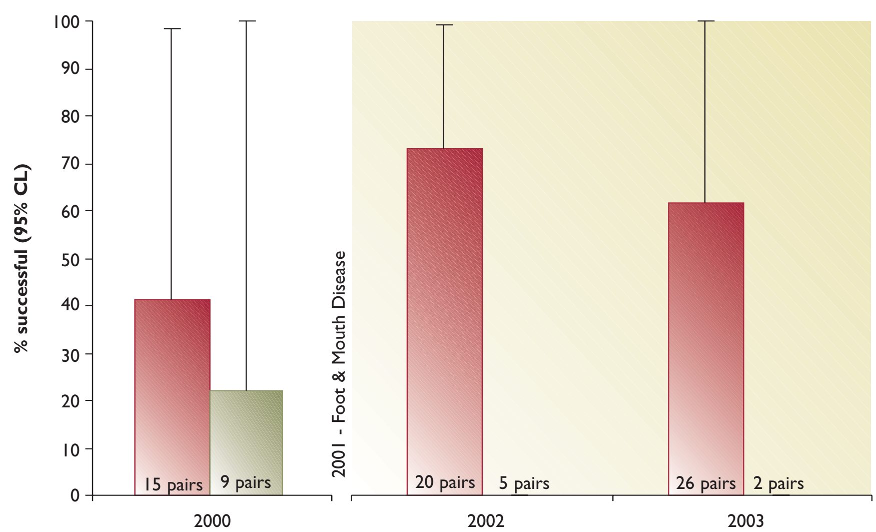


Figure 3

Percentage of lapwing pairs (and total number of pairs) rearing at least one chick. (Calculations as for Figure 1.)

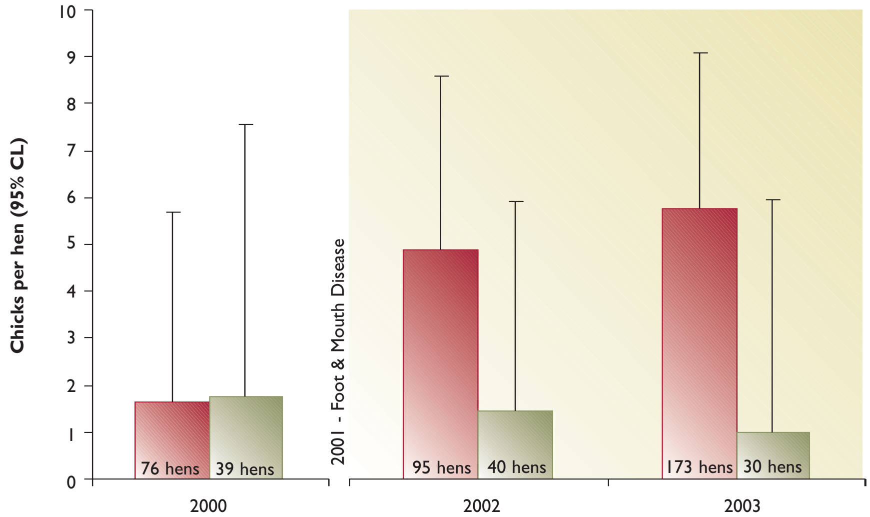
Experimental keepered plots

Non-keepered control plots

Predator control takes place on experimental keepered plots

Figure 4

Average number of chicks per hen produced by red grouse pairs (and hen number). (Calculated from two plot values.)



pairs in most cases are small and the influence of other factors cannot be ruled out at this early stage. We can therefore draw no conclusions until the experiment has run its full term. Conditional on the assent of the Scientific Advisory Committe, the keepering will switch from Otterburn to Bellshiel at the end of 2004 and the experiment will end in 2008.

Site of our Upland Predation Experiment at Otterburn in Northumberland. (Louise Shervington)

Poor year for Langholm's harriers and grouse

We continue to monitor numbers of breeding hen harriers and other predators (foxes, mustelids and crows) in relation to numbers of red grouse and other prey (songbirds, waders and voles) on Langholm Moor, the principal study area of the Joint Raptor Study, which took place from 1992 to 1997.

Only two pairs of harriers bred in 2003, the lowest number since 1992. Of these, a pair fledged one chick, and the other pair lost their chicks despite hatching five. The cause of loss remains unknown. Overall, harrier breeding success in 2003 was the lowest since 1993 (see Figure 1).

Spring grouse numbers were also the lowest since standardised counts began in 1993, with a fall from a peak in 1994 of 19.4 birds per 50 hectares to a low this year of 3.9 per 50 hectares, a decline rate of 16% per year. Breeding success was a little better in 2003 than in 2002, with a ratio of 1.1 young per adult grouse. However, overall densities of grouse in July continued to fall, with an average decline rate of 20% per year from 1992 to 2003 (see Figure 2).

Key findings

- Hen harriers had their lowest breeding success at Langholm since the Joint Raptor Study began.
- Spring grouse were at their lowest since 1994.
- Red grouse breeding success was up on 2002, but July densities fell.
- There were no gamekeepers on the moor in 2003 and no control of foxes, crows, stoats or weasels.

David Baines

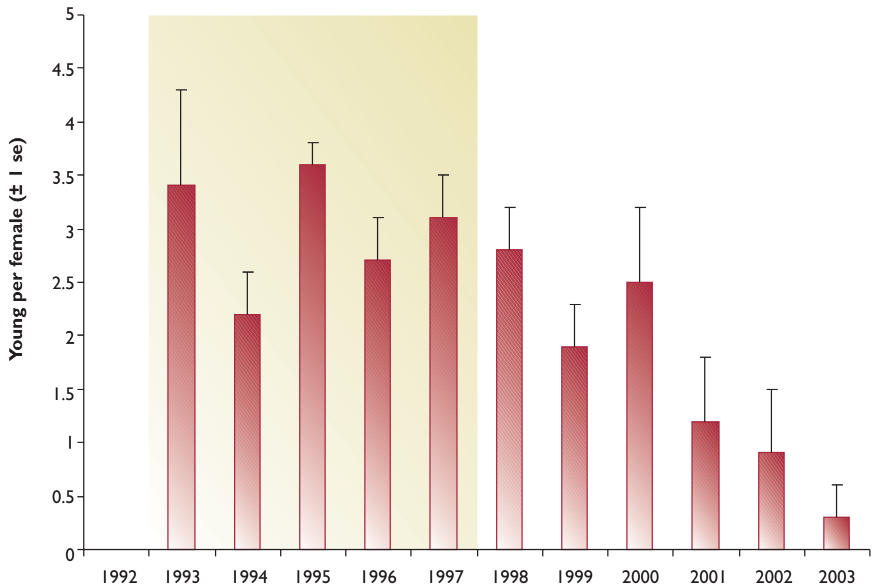


Figure 1

Average number of young produced per female harrier breeding attempt 1992-2003

Period of the Joint Raptor Study

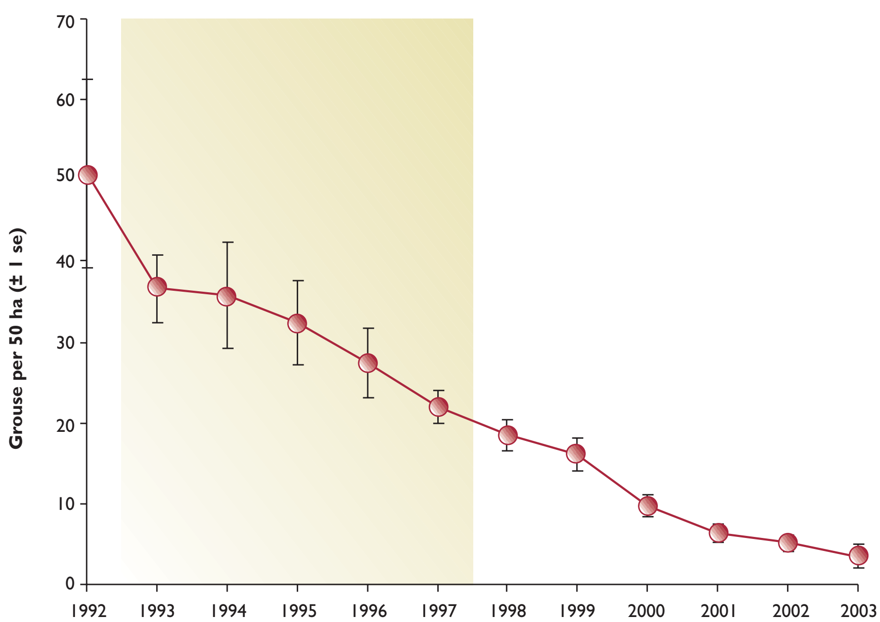


Figure 2

Average number of red grouse (young and adult) counted at Langholm on 10 50-hectare areas in July 1992-2003

Period of the Joint Raptor Study

A lack of keepering has been disastrous for both red grouse and hen harriers at Langholm. (Laurie Campbell)

Extent of grouse moor management surveyed

Key findings

- A high proportion of grouse moors are SSSIs, showing their environmental quality.
- Management for red grouse increases the chances of breeding waders and black grouse being present.

Julie Ewald

Since 1999, The Game Conservancy Trust, in collaboration with the National Gamekeepers' Organisation (NGO), the Moorland Gamekeepers' Association (MGA) and the Scottish Gamekeepers' Association (SGA), has collated a survey of their gamekeeper, stalker and ghillie members. This work has been funded by the Countryside Alliance, the NGO and many anonymous donors. The purpose of our survey was to document management carried out for game management.

Our survey now covers 19,780 square kilometres (or 4.9 million acres), and enables us to look at differences in habitat management between groups of estates based on either location or quarry species, and sets this habitat management into its biological context. This article covers management carried out on moorland estates, focusing on moorland management.

We analysed information from 270 estates covering over 11,750 square kilometres of the British uplands, dividing them into groups based on the main quarry species: red grouse only; red grouse and red deer; and red deer only. The location of the estates within the British uplands determines, through habitat and species availability, the main quarry species. Estates managed solely for red grouse were mainly in southern Scotland, England and Wales. Estates managing both red grouse and red deer were mainly in north-eastern Scotland, with those managed solely for red deer in north-western Scotland (see Figure 1).

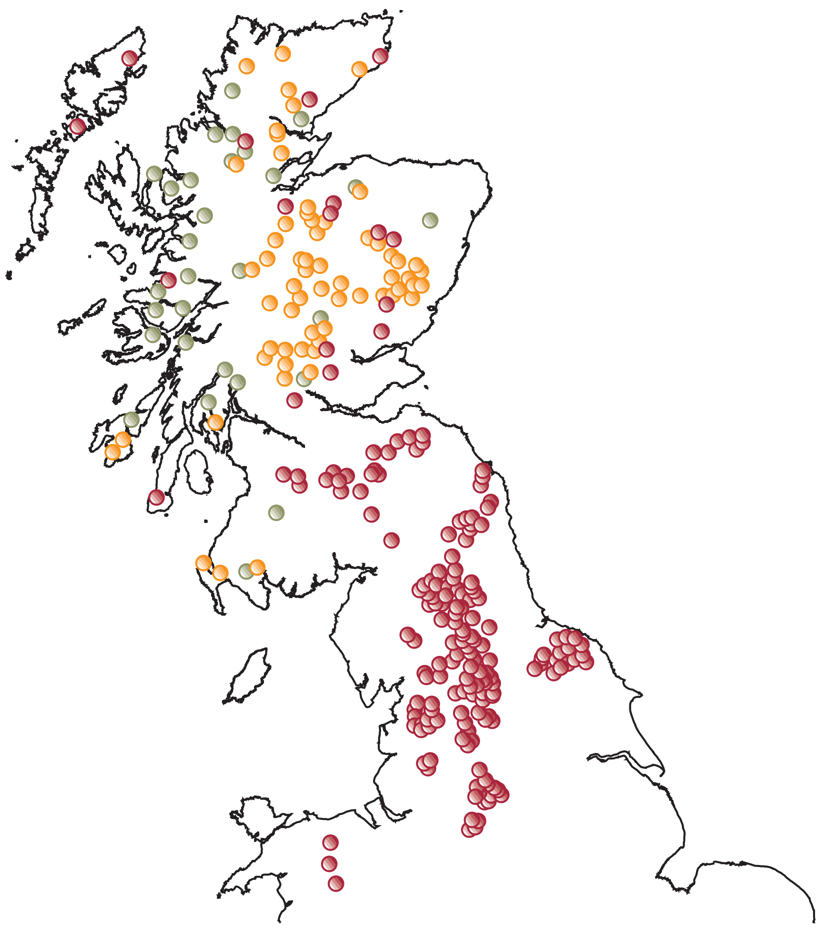
Figure 1

Distribution of different sorts of shooting estates within the uplands of the UK. Symbols indicate estates that have returned a survey form

Grouse moors

Grouse moors/red deer forests

Red deer forests



Our survey enables us to map the extent of moorland management for grouse. (David Mason)

Location leads to differences in the estates' size and their habitat. Red grouse estates in England were smaller than in Scotland by an average of 300 hectares. In Scotland, grouse moors were roughly half the size (3,300 hectares) of the other two types of estate (7,000 hectares). The proportion of the area of moorland on English red grouse estates was also significantly less than in Scotland (39% compared with 47%), with grassland (a combination of improved and semi-natural grassland) making

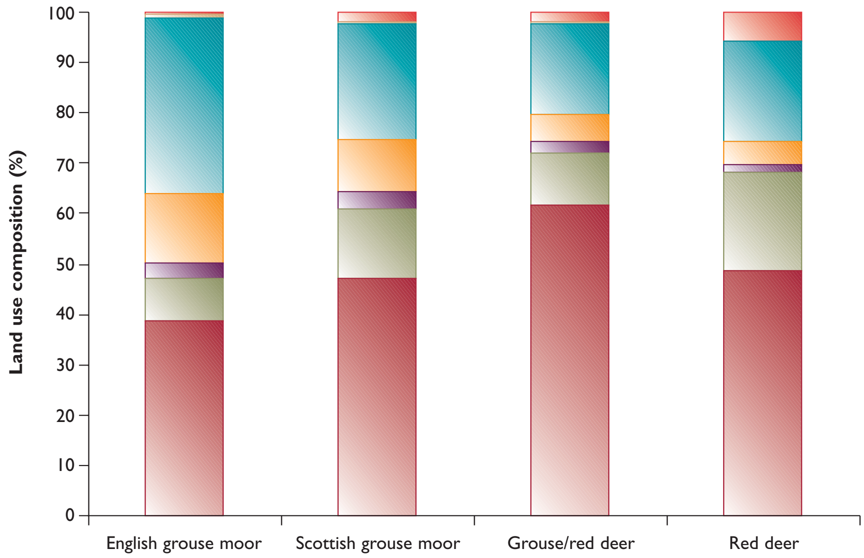


Figure 2

Composition of land use on four types of upland shooting estate

- Other
- Built up
- Semi-natural grass
- Improved grass
- Arable/horticultural
- Woodland
- Montane/heath/bog

up about 49% of the area compared with 33% in Scotland (see Figure 2). Scottish red grouse estates and red deer estates had less moorland than the estates managed for both (48% versus 62%), with red grouse estates having more of their area made up of grassland (33%) than did red grouse and red deer estates (27%). Estates managed solely for red deer had a greater proportion of their area covered by woodland (19%) than did the other estates (red grouse - 14%; red grouse and red deer - 10%). Red grouse estates had labour inputs twice as high per unit area than other land uses, were more likely to undertake muirburn and other heather management practices, and when they did manage heather, they managed a larger proportion of their estate.

One measure of environmental quality is the amount of land designated as Sites of Special Scientific Interest (SSSI). On average, SSSIs make up 16% of the upland area of Britain, and the shooting estates in our survey covered 15%. Shooting estates accounted for 29% of this upland SSSI area compared with an expected 16% if it were randomly distributed. We then compared the breeding distributions of upland waders and black grouse, as published in the *1989-93 Atlas of Breeding Birds* (British Trust for Ornithology), with areas of moorland management. For each 10x10 kilometre square in the uplands, the *Atlas* specifies presence or absence of breeding black grouse, dunlin, curlew, golden plover, lapwing, redshank and snipe. By overlaying estate maps, we quantified the percentage of managed moorland (where heather was burnt and predators controlled). We found positive associations between presence/absence and percentage management for all these species (see Figure 3). Management for red grouse led to significantly improved chances of having breeding waders and black grouse on the moor. There is little doubt that moorland management has benefits that extend far beyond red grouse.

There is a higher likelihood of snipe being found on moorland managed for grouse than elsewhere. (Louise Shervington)

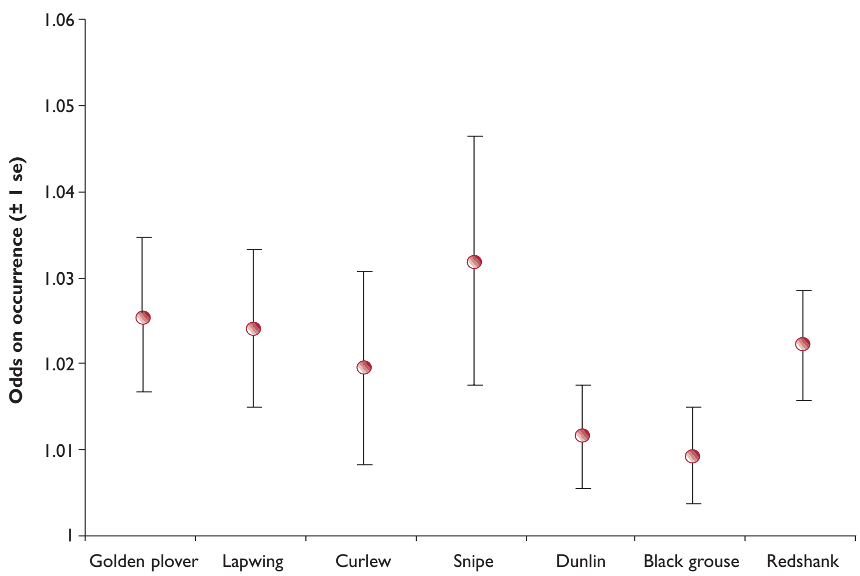
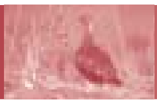


Figure 3

Likelihood of the occurrence of breeding birds on moorland managed for grouse moors. Figures above 1.0 indicate higher likelihood of presence.



Mountain hare cycles explained by parasites

Key findings

- The gut parasite *Trichostrongylus retortaeformis* has little impact on overall survival of adult hares.
- *T. retortaeformis* significantly reduces fecundity of female hares.
- The effect is enough to cause a cycle of regular population crashes in hares, similar to those seen in red grouse.

Scott Newey

As in Euro-Scandinavia, mountain hares in Scotland undergo regular changes in abundance. In the Highlands these fluctuations tend to occur every seven to 10 years over the course of which hare density can change 10-fold to reach numbers in excess of 250 hares per square kilometre (100 hectares). The reasons for these changes remain unclear. We suspected that intestinal parasites similar to those found in red grouse might be responsible, so we set out to test this.

Theory suggests that four criteria of a host-parasite relationship can, in certain circumstances, bring about cyclical changes in abundance. These are when:

1. There is a time delay in larval parasites joining the adult parasite population.
2. Parasites are randomly distributed in the host population.
3. Parasites have only a small detrimental effect on host survival.
4. Parasites substantially reduce host fecundity.

Trichostrongylus retortaeformis, the species of parasitic worm found in the guts of mountain hares, has a direct life-cycle. This means that female worms in the hare's gut produce eggs, which are passed out in faeces. The eggs hatch into larvae which, after going through two more larval phases, become infective and are ingested by hares as they feed. This life-cycle means that there is a delay between the emergence of eggs and infective larval parasites entering the hare. We know, therefore, that the first criterion is true. Over the winter of 1999/2000, with the assistance of 30 Highland shooting estates, we collected gut samples from nearly 600 shot hares. By counting the number of parasitic worms in each hare, we established that although they are not randomly distributed within hares they show a low degree of aggregation, similar to that in the red grouse-*T. tenuis* relationship. This suggests that the mountain hare-*T. retortaeformis* system is close to meeting the second criterion.

Fewer leverets are born to female hares carrying parasites than to those without. (Laurie Campbell)

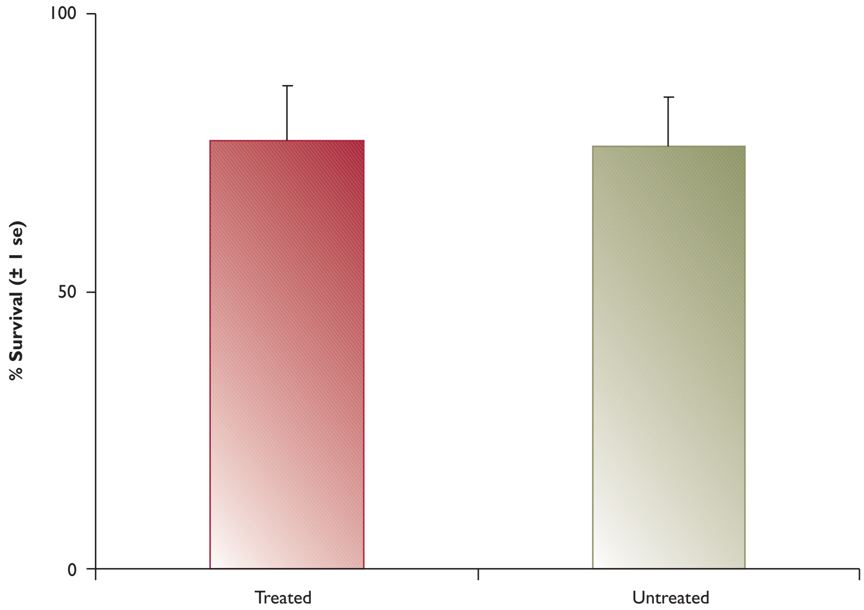


Figure 1

Survival among adult female hares treated for worms and those untreated

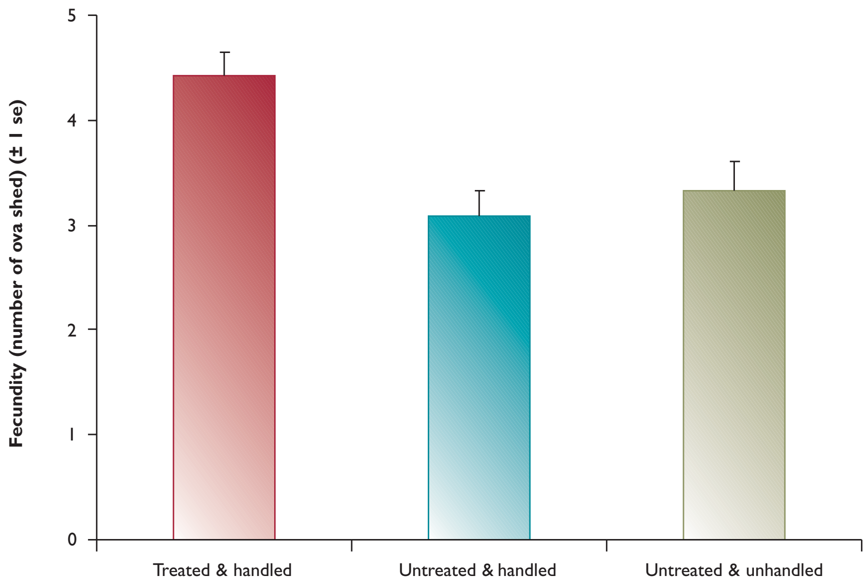


Figure 2

Fecundity of hares treated for worms and those untreated

The third (parasites have little effect on survival) and fourth (parasites reduce reproductive success) criteria were more difficult to investigate. Over the years 2000-2003 we did a series of field experiments to assess the impact of *T. retortaeformis* on hare survival and fecundity. We live-trapped 41 mountain hares in early winter, fitted each female with a radio-transmitter and gave alternate hares an injection of Ivermectin – a drug that kills intestinal parasites such as *T. retortaeformis*. Using radio-telemetry we monitored each hare's survival and reproductive success. This study showed that experimentally reducing *T. retortaeformis* infection has little impact on adult female hare survival (see Figure 1), but removing parasites as the females go into the winter has a marked effect on fecundity – females that were treated with Ivermectin produced around 30% more young than untreated females (see Figure 2).

The results of the field experiments suggest that *T. retortaeformis* has little effect on survival, but dramatically reduces fecundity. The mountain hare-*T. retortaeformis* relationship therefore satisfies the criteria needed to produce regular and large changes in mountain hare abundance. As such, we conclude that *T. retortaeformis* could be responsible for causing the regular and large-scale declines in hare populations.

Tick treatment for sheep keeps louping ill at bay

Key findings

- Vaccination of sheep to control ticks reduces incidence of louping ill in red grouse.
- It is possible to suppress louping ill to levels where the impact on red grouse is kept low.

Dave Newborn

The sheep tick, the carrier of the louping ill virus. (The Game Conservancy Trust)

Louping ill is a viral disease transmitted by sheep ticks (*Ixodes ricinus*) and has been recorded for more than 200 years in Britain in sheep flocks. A recent study showed that it first made its appearance in the UK about 800 years ago. However, its introduction to the heather uplands was probably as late as the 19th century as sheep farming expanded. For this reason red grouse may have only recently come into contact with the virus.

Louping ill is mainly a disease of sheep, although other domestic animals such as cattle, horses, pigs, goats and dogs can also be affected, as can red grouse. In red grouse the virus is responsible for high levels of mortality, with 79% of infected grouse chicks dying from the virus in laboratory and field conditions. It can also cause severe and potentially fatal encephalitis (swelling of the brain) in humans. It is because of its impact on red grouse chick survival that we have been working on control of louping ill since the late 1970s.

In 2001 we reported on the success of treating the major tick hosts (sheep) with acaricides (tick-killing pesticides). Some English estates have adopted this treatment along with vaccination to reduce the prevalence of louping ill in their sheep flocks. A vaccinated sheep produces antibodies which 'kill off' the virus, thus reducing the likelihood of the sheep passing the virus on via the tick to grouse. The vaccination is a split dose with two inoculations a minimum of two weeks apart administered before the sheep return to the moor as one-year-old animals. We have demonstrated that as the maternal antibodies wane in late summer, unvaccinated lambs can amplify and spread the virus. To prevent this, replacement ewe lambs should receive their first vaccination at shearing in July and the second at any time before they return to the moor in the spring.

To test the effectiveness of this sheep vaccination programme on the prevalence of louping ill in red grouse, we collected blood samples from immature red grouse on shoot days. Adult birds do not necessarily reflect louping ill prevalence in the year of sampling, so we do not sample them. From the blood samples we collect, we extract the clear serum, which contains the viral antibodies. However, as louping ill causes 79% mortality in red grouse, most of the birds that have come into contact with the virus will have already died by the start of the shooting season.

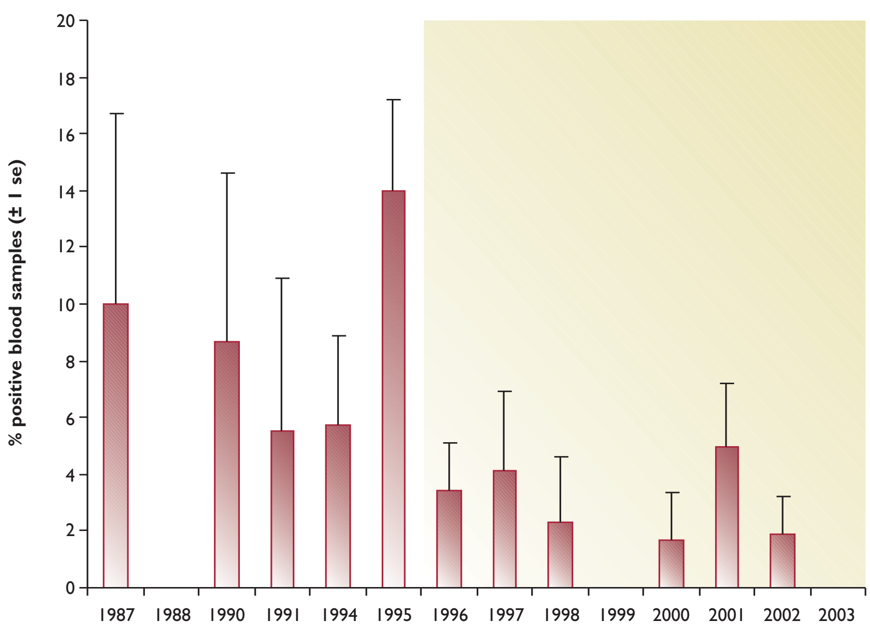
We measured the level of louping ill infection in red grouse on 10 estates in the North York Moors, with a range of vaccination programmes on their sheep flocks. Louping ill prevalence dropped from an average of 9.8% positive samples before 1995 to an average of 2.2% since 1995 (see Figure 1).

Although louping ill has not been eradicated, the number of positive blood samples has decreased following the implementation of the double vaccination

Figure 1

Louping ill prevalence in blood samples of young red grouse shot on 10 estates in the North York Moors

Double vaccination programme in place



Grouse can benefit from ticks being removed from sheep. (Dave Newborn)

programme since 1995 - with no positive samples in 1999 and 2003. However, tick numbers were also reduced with acaricide and the reduction in louping ill antibodies in red grouse may also be due to reduced tick numbers.

With correct application of these techniques it is possible to suppress louping ill and sheep ticks to levels where their impact on the red grouse population is reduced to a minimum.

Sheep, ticks, grouse and louping ill are closely linked. (Laurie Campbell)

A sheep being treated for ticks. (Dave Newborn)

New method for counting red grouse

Key findings

- 'Distance' sampling is a practical method for counting grouse, being broadly accurate and time efficient.
- Contour maps show that grouse are not evenly distributed across the moor. This allows us to investigate what reasons affect this.

Phil Warren

The standard Game Conservancy Trust grouse counts yield information on density and breeding success, but little on the patterns of breeding success, movements and mortality of grouse on a large scale. To count all grouse on 10,000 hectares of moor using pointing dogs is impractical, so we have tested a new method called 'distance sampling', which uses dogs to flush grouse along transect lines every 500 metres across the moor. This method requires a third of the time of the standard counts.

Since spring 2000, with the exception of spring 2001 when Foot and Mouth Disease prevented access, we estimated the abundance and distribution of grouse using this method in spring and July. Estimates of grouse density based on distance

Table 1

Red grouse density estimates for one of the study moors

Year	*Grouse density in spring (grouse per 100ha)*	*Breeding Success (chicks per hen ± 1se)*	*Total grouse density post breeding (grouse per 100ha)*	*Total grouse shot (grouse per 100ha)*
2000	99 (79-123*)	4.6 (+0.2)	267 (202-353*)	109
2001	No count	6.5 (+0.2)	482 (384-606*)	187
2002	188 (158-225*)	4.6 (+0.2)	357 (276-460*)	211
2003	119 (102-139*)	4.8 (+0.2)	278 (219-350*)	182

* 95% confidence limits

It is difficult to count grouse in large areas without using a method such as 'distance' sampling. (Laurie Campbell)

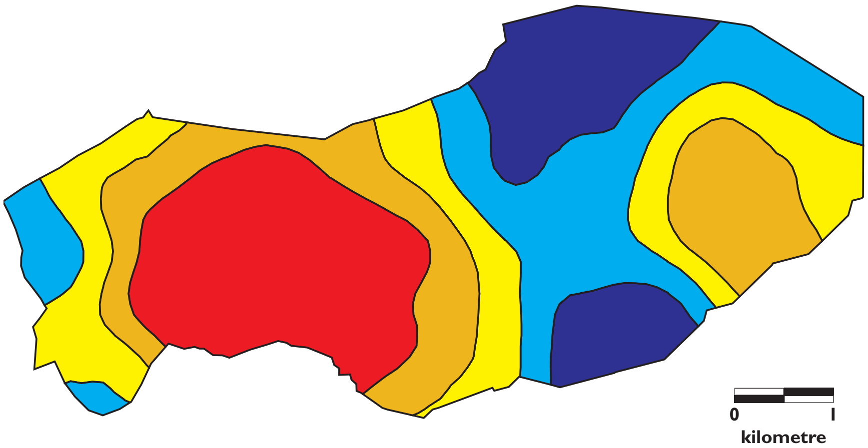


Figure 1

Contour density map of total grouse distribution for one of the study moors in spring 2000

- Total density 26 pairs or more per 100 hectares
- Total density between 23 and 26
- Total density between 20 and 23
- Total density between 17 and 20
- Total density below 17

sampling are provided in Table 1 and show that density estimates in spring are comparable with total density in July and subsequent numbers of grouse shot. We also generated contour density maps of grouse (see Figure 1) from the recorded location of all grouse flushed. These illustrate that grouse are not evenly distributed across the moor and this enables us to investigate further what factors are affecting grouse distribution such as heather burning and disease.

We needed to be sure that the grouse density estimates and the resulting maps were reliable and repeatable. We therefore compared the results from three other methods: counts of spring calling cocks, total counts of grouse in spring (drive counts) and brood counts by moorland gamekeepers in July/August.

Grouse are highly territorial and at dawn cocks perform song flights. We counted calling cocks in spring 2000 in 17 25-hectare blocks across the study moors located in relation to areas of low, medium and high grouse density identified from that spring's contour density map. In addition in 2000 and 2003, we surveyed the total numbers of grouse in spring within 12 25-hectare blocks using a line of beaters. Again these blocks were distributed across the moor in relation to areas of low-, medium- and high-density areas of grouse. We also compared distance sampling estimates with gamekeepers' brood counts on the shooting drives.

The results from the distance sampling compared favourably with those from the spring calling cocks, total spring counts and the gamekeepers' July counts (see Figure 2). It seems that distance sampling produces similar results to more intensive methods and is suitable for applying to large areas of moorland.

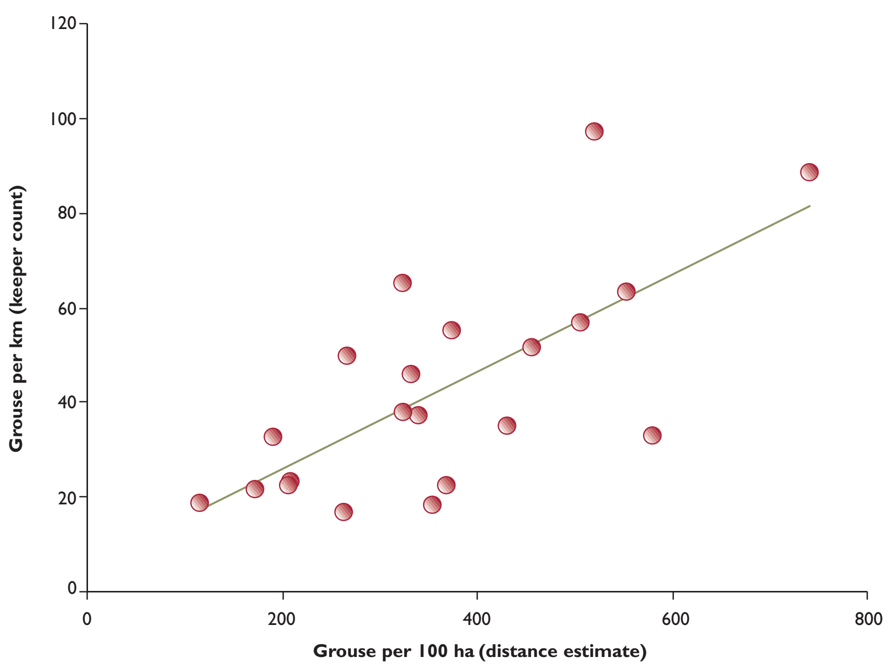
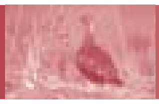


Figure 2

Relationship between nnumbers of grouse counted by gamekeepers in July compared with estimates of grouse density from the distance sampling method

Note: keepers' counts record a total number seen on a linear walk, which gives an index of the number present. Our distance sampling technique provides an estimate of the actual number present on a given area of moor. There is a linear relationship between the two measures of abundance.



Are parasites of red grouse becoming resistant?

Key findings

- There is no evidence of resistance to fenbendazole in red grouse.
- There is no relationship between the amount of the drug used and larval hatching success.
- It is unclear whether resistance could build up in future.
- We recommend taking steps to avoid resistance developing.

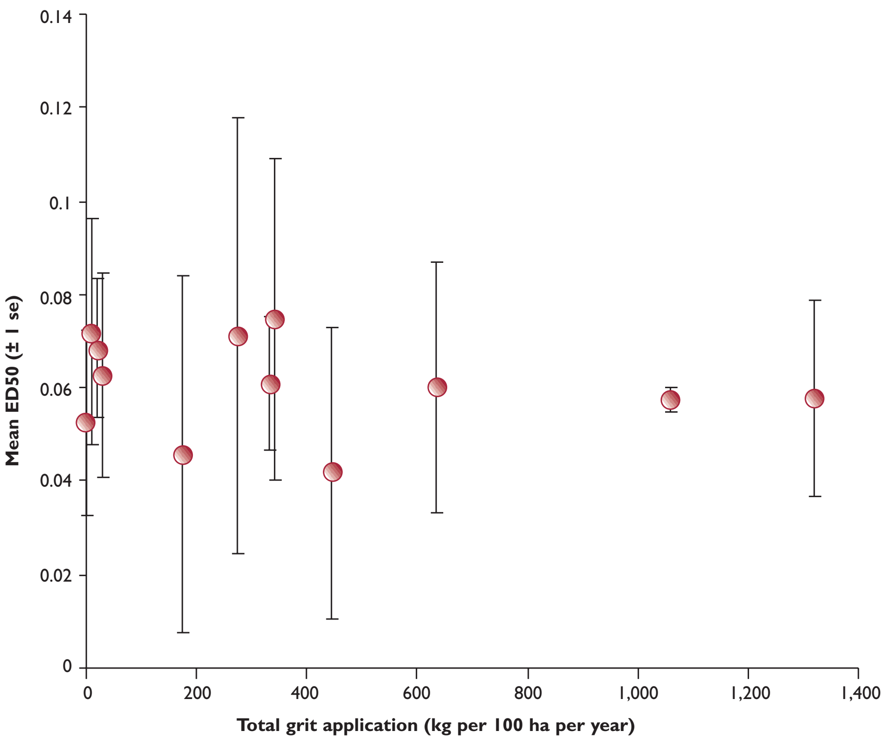
Ruth Cox

Control of strongyle worms is vital for healthy grouse stocks. (David Mason)

Red grouse populations in the UK show cyclic fluctuations with 'boom' and 'bust' years. The nematode worm, *Trichostrongylus tenuis*, a gut parasite causing strongylosis, drives these cycles through reducing grouse survival and breeding success. Crashes in grouse numbers following parasite increases can reduce income substantially on many

Figure 1

Comparison of the concentration of drug required to prevent 50% of the worm eggs hatching (ED50) and the total amount of medicated grit used.



upland estates and, over the last 15 years, medicated grit has been used to reduce worm burdens in red grouse. The active drug in medicated grit is fenbendazole, which kills the eggs and larvae of worms as well as the worms themselves. It reduces worm burdens in wild red grouse by about 40%, and improves grouse breeding success by increasing chick survival.

Many managers have become concerned that frequent use of a wormer may result in worms becoming resistant to the drug, hence lowering its effectiveness. This has been recorded in sheep and pigs with serious health, welfare and economic repercussions.

We investigated whether any resistance to fenbendazole has developed in strongyle worms in red grouse on 12 moors in northern England. Each moor differed in the amount and frequency of medicated grit provided. The amount of grit used ranged from 0 to 187 kilograms per square kilometre (100 hectares) per year. Length of treatment ranged from zero to seven years.

We assessed resistance of parasites on each moor using an egg-hatch assay, which tests whether a soluble form of the worming drug inhibits the hatching of freshly collected worm eggs. We extracted worm eggs from five samples of caecal faeces taken from each moor and incubated them in different concentrations of the drug for 48 hours. We calculated the proportion of eggs that failed to hatch and the concentration of drug that prevented 50% of eggs from hatching in each sample. This is called the 'ED50'.

Resistance to fenbendazole does not appear to have developed on any of the study sites. An ED50 value of more than 0.1 micrograms per millilitre indicates probable resistance, but the highest average value we found for any moor was only 0.074 micrograms per millilitre. Furthermore, the total amount of grit used on the moors did not significantly affect worm hatchability (see Figure 1) and there is no relationship between the amount of drug used and hatching success.

Currently, there is no evidence of drug resistance in strongyle worms in grouse in the UK. Whether resistance could develop in the future is determined by the extent that worms surviving the drug treatment contribute their genes to future generations. This is influenced by factors such as the nature of the drug, the parasite and the host-parasite system, including frequency and timing of treatment, the life-cycle of the parasite and the transmission of parasite to host. It is therefore difficult to say whether resistance to fenbendazole may ultimately develop in the future.

It is important that the effectiveness of currently available compounds is maintained. It is therefore worth considering strategies that could be employed to avoid resistance developing. For instance, it may help to combine the general use of medicated grit with the 'catch and treat' or dosing method using drugs such as Levamisole hydrochloride. Direct dosing would be most effective when high worm infection is expected, often in spring, whereas medicated grit could help to keep worm burdens at a low level.

T. tenuis *worm (top) and egg (above). (Ruth Cox)*

Provision of grit is a standard part of grouse management. (Sophia Miles)

Woodland and lowland game ecology in 2003

Key achievements

- Careful siting of, and reduced stocking densities in, pheasant release pens can reduce or eliminate their impact on sensitive woodland plants.
- Grey partridges increased by 76% in response to management at Royston.
- GIS mapping quanitified the amount of lowland game cover and its consequences as food for songbirds.
- We gained a better understanding of disease, diet and raptor predation in grey partridges.
- Treating wild pheasants for parasites reduced the burden of worms in the environment.
- We quantified the fate of released pheasants.

Rufus Sage

Several of our lowland gamebird research programmes finished in 2003 and have produced some interesting findings. Roger Draycott's study of the effects of parasites on pheasants in East Anglia is reported on page 70 and his three-year study of wild breeding pheasants in Austria on page 68. Clare Turner's work on fate and dispersal in released pheasants continues at the time of writing, but we present some initial findings from this three-year study on page 74.

Our work on effects of releasing gamebirds on habitats and wildlife is also maturing. On page 72 we revisit a study undertaken in 1988 and draw new conclusions about when and how pheasant release pens might damage sensitive woodland ground flora and, importantly, how this can be avoided. Our study of the impacts of released pheasants on wider farmland habitats finished in 2003. We have collected data on wildlife and pheasant use from 120 sites in England and the analysis and write-up of these data is now a priority. Another extensive study will replace it in 2004, this time focusing on the effects of pheasant releasing outside the release pen, but within the same woodland. Sarah Callegari's study of the impacts of red-legged partridges on chalk grassland plants and insects involves six sites and she has finished the first year of experimentally excluding gamebirds from grassland patches.

In conjunction with the BTO, Andrew Hoodless and Nicholas Aebischer co-ordinated the first national survey of breeding woodcock, obtaining counts of displaying males from 947 sites. They were joined by Jean-Philippe Doucet (University of Lyon) who assisted with calibration work (see page 76). Hannah McLaughlin (Reading University) and Andrew Hoodless surveyed breeding waders in the River Avon floodplain and examined changes in numbers since 1996 in relation to management under different ESA options (see page 78). Mark Cunninghams' DTI-funded work on the ecological impacts of commercial short-rotation coppice crops continues. Early indications are that the sort of benefits to farmland wildlife identified in our earlier studies of experimental plots also apply to bigger plantations.

Much of our work has focused on how damage associated with pheasant releasing can be avoided. (David Mason)

Lowland game research in 2003

Project title	Description	Staff	Funding source	Date
Wild pheasant and partridge populations (see page 52)	*Long-term monitoring of breeding on wild bird estates*	*R Sage, M Woodburn, R Draycott, D Parish*	*Core funds*	*1996 - on-going*
Wildlife in short-rotation coppice	*Monitoring wildlife use of short-rotation coppice plantations*	*Rufus Sage, Mark Cunningham*	*DTI*	*2000-2005*
Austrian pheasant ecology (see page 68)	*Investigating winter habitat use and mortality of radio-tracked pheasants in Austria*	*Roger Draycott*	*M Hardegg*	*1999-2003*
Parasites and gamebirds in East Anglia (see page 70)	*Investigating links between nematode parasites and breeding in lowland gamebirds*	*Rufus Sage, Roger Draycott*	*Janssen Animal Health, Core funds*	*2000-2003*
Lees Court game and wildlife	*Economic and conservation benefits of released game management on a lowland shooting estate*	*Rufus Sage, Tracy Greenall*	*The Swire Trust, Lees Court*	*2000-2004*
Ecology of reared grey partridges	*Radio-tracking reared grey partridges to determine feasibility of releasing to restock*	*David Parish,*	*Scottish Fair, Various charitable trusts*	*1997-2004*
Monitoring East Lothian Local BAP	*Monitoring effects of LBAP measures on bird populations in East Lothian*	*David Parish, Hugo Straker*	*Various charitable trusts*	*2001-2004*
Control of willow beetle in short-rotation coppice	*Testing means of controlling willow beetle within crop to improve crop viability*	*David Parish, Steve Hubbard (Dundee Uni)*	*Carnegie Trust for Scottish Universities*	*2003-2004*
Avon Valley wader studies (see page 78)	*Monitoring long-term population trend in snipe, lapwing, and others*	*Andrew Hoodless Jean-Philippe Doucet*	*Charitable trust*	*On-going*
Woodcock studies (see page 76)	*National surveys and sonogram identification*	*Andrew Hoodless*	*Woodcock Club Wildlife Habitat and other charitable trust*	*2003*
Extensive farmland ecology	*Extensive study of impacts of pheasants on wood edge and hedgerows on farmland*	*R Sage, M Woodburn, R Draycott, M Cunningham, C Turner, A Hoodless*	*Research Funding Appeal*	*2002-2003*
Released game on chalk grassland	*The impact of released pheasants and partridges on butterflies on chalk grassland*	*Rufus Sage, Sarah Callegari*	*English Nature*	*2002-2005*
Release pen flora (see p72)	*Re-analysis of 1988 study*	*Rufus Sage*	*Core funds*	*2003*
Radio-tracking released pheasants	*Documenting fate and dispersal in released pheasants*	*Rufus Sage, Clare Turner*	*Research Funding Appeal*	*2001-2004*
Partridge count scheme (see page 53)	*Nationwide monitoring of grey and red-legged partridge abundance and breeding success*	*Nicholas Aebischer, Stephen Browne, Julie Ewald, Nina Graham, Dave Parish, Edward Darling*	*Core funds*	*1933 - on-going*
National Gamebag Census (see page 92)	*Monitoring game numbers with annual bag records*	*Nicholas Aebischer, Julie Ewald, Claude Gillie*	*Core funds*	*1961 - on-going*
Sussex study (see page 54)	*Long-term monitoring of partridges, weeds, invertebrates, pesticides and land use on 62 square kilometres of the South Downs*	*Nicholas Aebischer, Steve Moreby, Dick Potts (consultant)*	*Core funds*	*1968 - on-going*
GIS project (see page 40 and 58)	*Investigation of the extent and consequences of game and fish management for wildlife in Britain*	*Julie Ewald, Neville Kingdon, Stephen Tapper, Nicholas Aebischer, Nina Graham*	*Countryside Alliance*	*1999-2003*
Grey partridges and raptors (see page 64)	*Investigation of grey partridge behaviour, habitat use and survival in relation to raptor abundance*	*Nicholas Aebischer, Mark Watson*	*GC-USA*	*2000-2003*
Norfolk partridges (see page 60)	*Study of influence of diet on the disease susceptibility of grey partridges in Norfolk*	*Nicholas Aebischer, Stephen Browne*	*National Gamekeepers' Organisation, landowners*	*2001-2003*
Bag statistics review	*Review methods of collecting bag statistics on birds in the UK*	*Nicholas Aebischer, Stephen Browne, Niall Moore (CSL)*	*Defra*	*2003-2003*

Lowland game counts

Key findings

- The last three years have been good for pheasant productivity.
- Stocks of wild pheasants on estates that manage these birds are at their highest since counts began.

Roger Draycott

Pheasants

In collaboration with a number of estate game managers, we conduct spring and autumn counts of pheasants on a range of wild pheasant shooting estates in East Anglia each year. The number of estates fluctuates slightly from year to year, but averages 11 (range six to 24). The counts provide an assessment of the stock and productivity of wild pheasants and identify long-term trends in abundance. Before the scheme began in 1996, we did not have a clear picture of the status of wild pheasants in Britain.

Our counts show that productivity is subject to large fluctuations from year to year (see Figure 1), due primarily to the weather conditions and insect food availability during the brood-rearing period. After a poor breeding season in 2000, the last three years have been good for wild pheasant production. This is reflected in the breeding stock (see Figure 2), which appears to be increasing after a decline in the late 1990s. Consequently, the stocks of wild pheasants on our count sites are probably at their highest levels since the count scheme began. However, the status of wild pheasants on estates with high levels of pheasant releasing and on keepered land remains unclear.

Figure 1

Young-to-old ratio of pheasants on estates in East Anglia. Counts take place on an average of 11 sites each year (range six to 24).

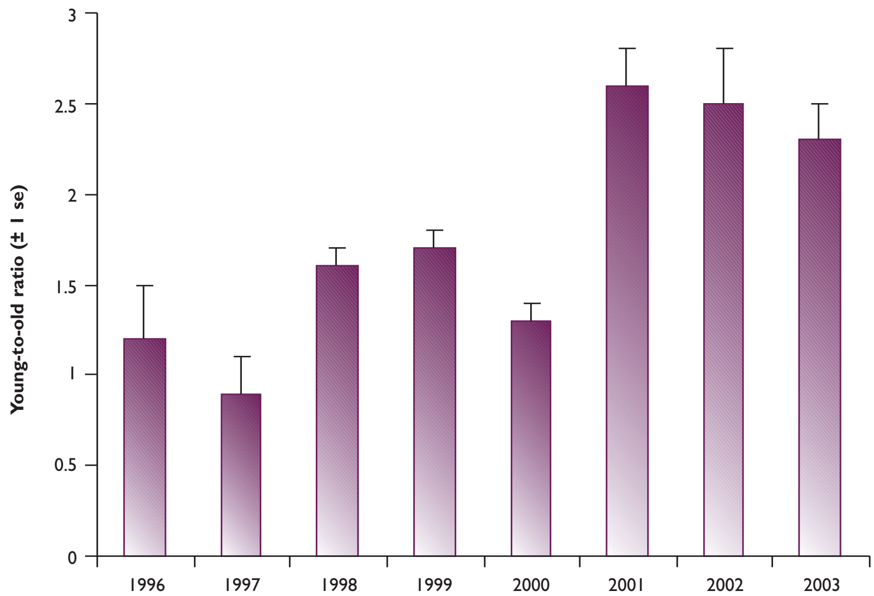


Figure 2

Breeding densities of pheasants on estates in East Anglia. Counts take place on an average of 11 sites each year (range six to 24).

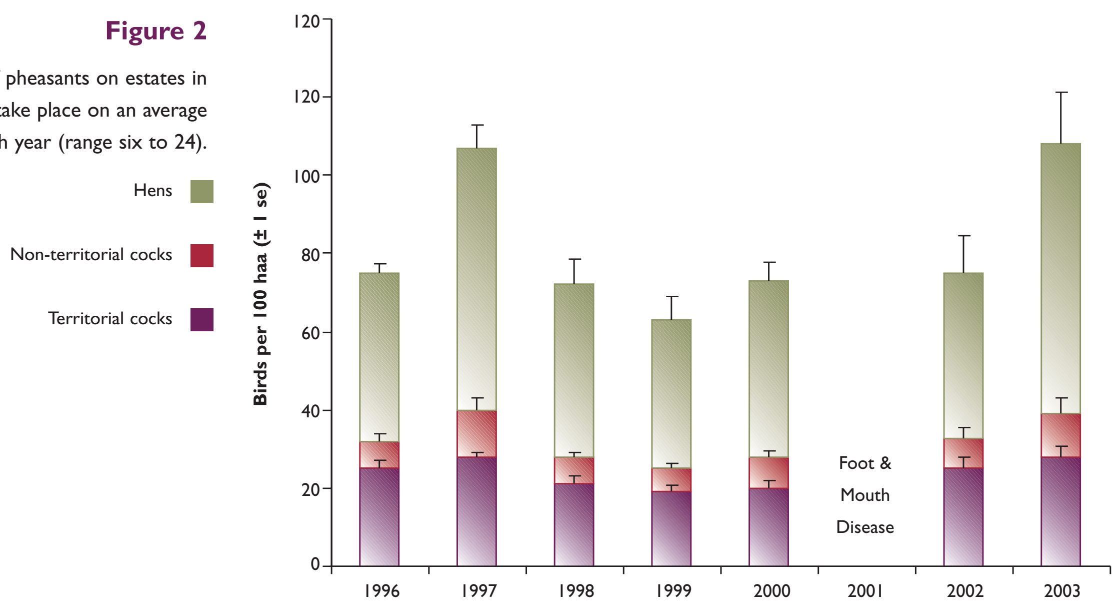


Table 1

Partridge Count Scheme, autumn 2003

a. Grey partridges

	Number of sites		***Young-to-old ratio***		***Autumn density (birds per km² (100ha))***	
Region	*2003*	*(2002)*	*2003*	*(2002)*	*2003*	*(2002)*
South	81	(39)	2.4	(1.8)	7.0	(4.9)
Midlands	90	(34)	2.9	(2.5)	10.3	(10.0)
Eastern	155	(101)	2.6	(2.3)	22.4	(18.5)
Northern	91	(14)	3.4	(2.6)	17.0	(5.5)
Scotland	103	(40)	3.0	(2.9)	6.2	(18.4)
Overall	**520**	**(228)**	**2.8**	**(2.4)**	**13.2**	**(14.3)**
Grey partridge recovery project	*2003*	*(2002)*	*2003*	*(2002)*	*2003*	*(2002)*
Demonstration area	6	(6)	2.9	(3.0)	39.0	(28.8)
Reference area	5	(5)	4.1	(1.8)	17.9	(6.3)

b. Red-legged partridges

	Number of sites		***Young-to-old ratio***		***Autumn density (birds per km² (100ha))***	
Region	*2003*	*(2002)*	*2003*	*(2002)*	*2003*	*(2002)*
South	51	(30)	1.4	(2.0)	22.9	(1.4)
Midlands	75	(31)	1.3	(1.1)	19.1	(7.6)
Eastern	112	(85)	0.9	(0.7)	26.3	(20.4)
Northern	51	(19)	1.7	(1.2)	5.5	(0.6)
Scotland	47	(27)	1.7	(0.4)	0.7	(2.3)
Overall	**336**	**(112)**	**1.1**	**(0.7)**	**12.5**	**(11.3)**
Grey partridge recovery project	*2003*	*(2002)*	*2003*	*(2002)*	*2003*	*(2002)*
Demonstration area	6	(6)	2.2	(1.1)	42.0	(18.5)
Reference area	5	(5)	2.1	(0.6)	33.4	(11.3)

Partridge Count Scheme

Table 1 shows the productivity and densities in the Partridge Count Scheme for 2003. The results are encouraging. The young-to-old ratio for grey partridges increased in every region of the country as a result of near perfect weather for breeding. Many sites achieved more than four young per adult bird. Although the autumn density in the count scheme has fallen, the number of grey partridges counted increased from 12,470 to 28,181 birds and the area covered increased from 87,000 hectares (217,000 acres) to 213,000 hectares (532,000 acres). A number of sites now have autumn densities of over 100 birds per hectare and one site has reached 247 birds per hectare.

The number of participants in the count scheme increased in 2003 from 698 to 1,341, and the number of sites making returns increased from 228 to 520. The area that has been mapped by the Geographical Information System (GIS) at Fordingbridge has reached 274,000 hectares (686,000 acres). In the spring there were 78,000 hectares (195,000 acres) that had densities in excess of the 2010 Biodiversity Action Plan (BAP) target, and this is a substantial increase on the 8,800 hectares (22,000 acres) recorded in 2002.

The first BAP target is to halt the decline of the species by 2005 and there is every indication that this will be achieved as a result of the good breeding seasons in the last three years. We hope that increasing levels of grants for environmental works within the Entry Level Scheme will further enhance the number of grey partridges.

Key findings

- Young-to-old ratio increased in 2003 thanks to good weather.
- Number of partridges counted increased.
- The area covered by the count scheme increased more than two-fold and the number of participants doubled.

Edward Darling

Key findings

- Chick survival rate increased.
- The number of adult grey partridges counted in the autumn slipped below 100 for the first time, having been over 14 at their peak (since our study began) in 1977.

Julie Ewald

Sussex study

2003 marked the 34th year of counting grey partridges and sampling cereal invertebrates on the Sussex Study Area. The good news was that the index of chick-food abundance derived from the invertebrate sampling was relatively high (see Figure 3), and the 2003 chick survival rate calculated from the brood sizes in the autumn counts confirmed this (see Figure 4). However, the outlook for grey partridges overall was disappointing: the number of adult birds counted in autumn slipped below 100 for the first time, and the estimate of spring pair density was below one pair per 100 hectares (see Figure 5). Several farms in the study area are now making a concerted effort to improve both nesting cover and chick-rearing habitat, with over 2.5 kilometres of beetle banks and five kilometres of conservation headlands being installed in 2003. These measures provide some hope for the future of grey partridges on the South Downs; next year's counts will be crucial in evaluating their success.

David Mason

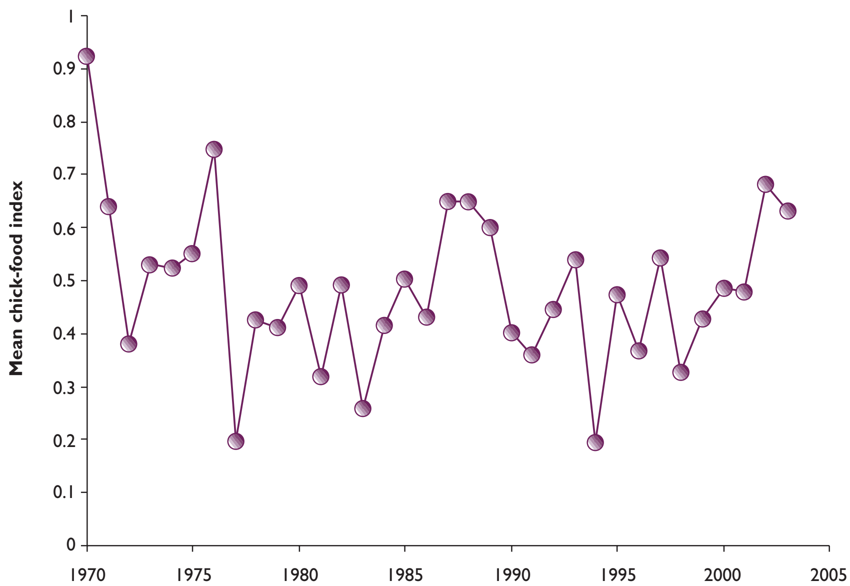


Figure 3

Availability of chick food in Sussex, 1970-2003

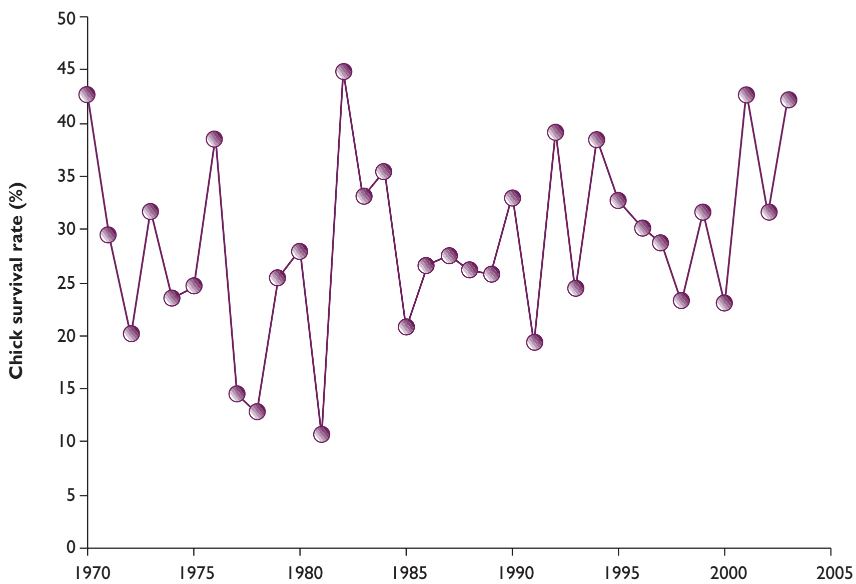


Figure 4

Grey partridge chick survival in Sussex, 1970-2003

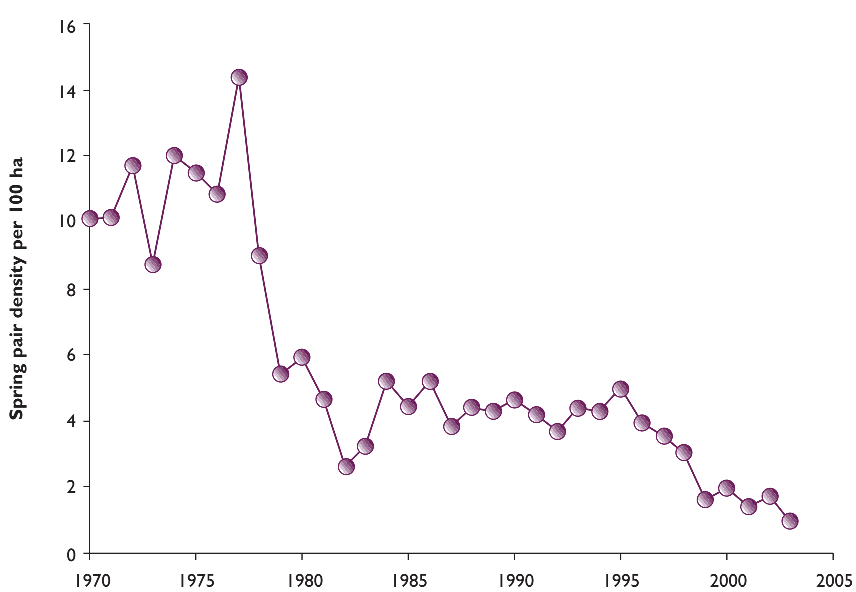


Figure 5

Grey partridge spring pair density per 100 hectares in Sussex, 1970-2003

Partridges respond well in our demonstration

Key findings

- Spring counts show a 76% increase in grey partridge numbers on the demonstration area (62% on the reference area).
- Autumn counts show high productivity in both areas of the study.

Nicholas Aebischer

The second year of the Grey Partridge Recovery Project is now complete. The project is run in conjunction with the Allerton Research and Educational Trust, and seeks to demonstrate how to restore numbers of wild grey partridges as part of the grey partridge Biodiversity Action Plan. Located south-west of Royston, Hertfordshire, our demonstration area is 10 square kilometres (1,000 hectares) of arable land on chalk, flanked by a reference area of similar size. Based on the predictions in *A Question of Balance*, we expect to increase the spring density of grey partridges from 2.9 pairs per square kilometre (100 hectares) in 2002 to 18.6 pairs per square kilometre through management. To do so, we have implemented four management protocols simultaneously, namely:

One of the project's resident grey partridge coveys. (Malcolm Brockless)

1. Predator control to improve the survival and breeding success.
2. Habitat improvement, relying on best use of set-aside and, where possible, contracting into existing agri-environment management options such as those offered under Countryside Stewardship.

Figure 1

Distribution of grey partridge coveys at Royston in autumn 2003, showing barren pairs, single males and brood sizes

Demonstration area

Reference area

Pair with no chicks (probable nest loss) ×

Single male (probable hen loss) +

Brood size (number of chicks)

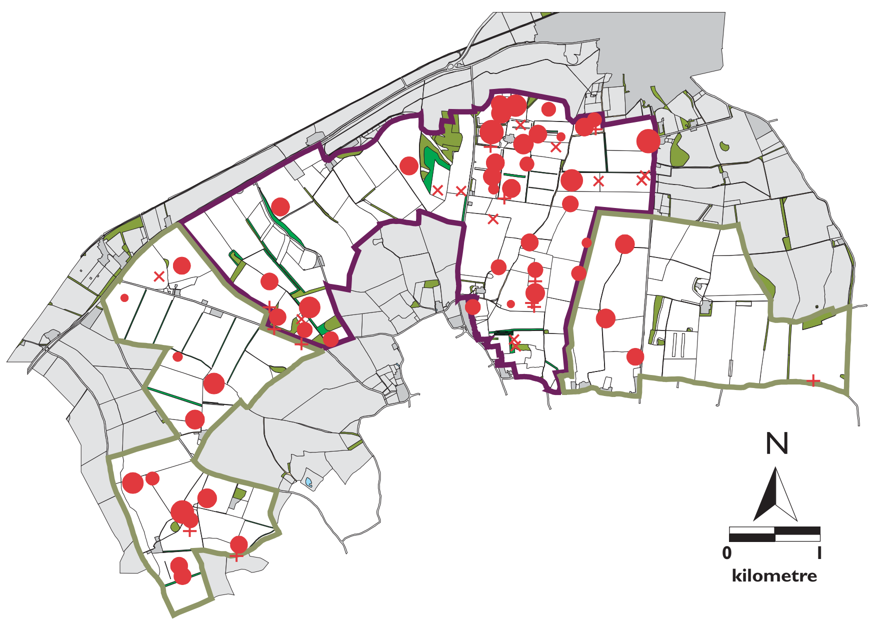
17+

13-14

9-10

5-6

1-2



Malcolm Brockless feeds the partridges to prepare them for the breeding season. (Malcolm Brockless)

3. Year-round supplementary feeding.
4. Maintaining pheasant numbers at 2001 levels, thereby providing some shooting on the area for local farmers.

Over the last two years we have counted partridges in March and in early September. All grey partridge adults were sexed, and in the autumn counts we recorded the number of young birds in each autumn covey.

In spring 2002 there were 2.9 pairs per square kilometre (100 hectares) on the demonstration area compared with 1.3 on the reference area. In 2003, after one year, the spring density on the demonstration ground had increased to 5.1 pairs per square kilometre (76% increase) compared with 2.1 on the reference area (62% increase).

The 2003 autumn counts (see Figure 1) showed high productivity. In fact, the young-to-old ratio of 4.2 on the reference area outstripped that of 2.9 on the demonstration area - the hot summer obviously helped chick survival. Both areas showed an increase over the previous year, with densities of 39.2 birds per square kilometre (28.8 in 2002) on the demonstration area, and 17.9 (6.3 in 2002) on the reference area.

The end of our second year at Royston is most encouraging. The spring density of grey partridges on the demonstration area has climbed above that predicted for unmanaged land, and we expect a further increase in 2004 thanks to high productivity in 2003.

Lapwings have also bred on the study site since we began the project. (Malcolm Brockless)

Strips of wild bird cover provide food for Royston's farmland birds and insects. (Malcolm Brockless)

Lowland game management surveyed

Key findings

- 89% of lowland shooting estates surveyed provide supplementary feed to gamebirds through the winter.
- 86% continue feeding until May.
- 80% plant game cover, totalling 3.0% of the arable area.
- The estates surveyed support 17,000 more farmland birds than they would have done without game cover.

Julie Ewald

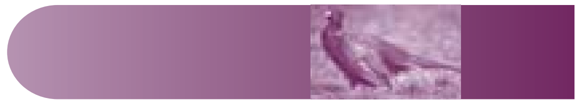
In our GIS project, which began in 1999, as well as on upland estates (see page 40) we have looked at game management on lowland estates. Through a survey of our own gamekeeper members and those of the National Gamekeepers' Organisation (NGO), the Moorland Gamekeepers Association (MGA) and the Scottish Gamekeepers' Association (SGA), we have been able to document management carried out for game management. This work has been funded by the Countryside Alliance, the NGO and many anonymous donors.

The survey (which covers 19,480 square kilometres including upland estates) enables us to look at differences in habitat management between groups of estates based on either their location or their quarry species, and sets this habitat management into its biological context. This article covers management carried out on lowland estates, focusing on the provision of food resources in game cover crops.

Winter and spring feeding and game cover crops are important aspects of lowland game management. These additional food sources improve body condition of gamebirds and also attract songbirds. Game crops are principally for the autumn months and gamebird feeders for later in the winter and spring.

Of a total of 1,227 estates that returned our survey forms, 1,088 (89%) provided supplementary food to gamebirds from September to February. 86% continued feeding to May, providing food also for birds like corn buntings, yellowhammers and tree sparrows. The majority of estates (93%) used hoppers, with 72% also providing food via hand-feeding. Nearly 29,000 tonnes of food were distributed by our respondents. The most common food was wheat (87%). Others were barley, maize, propri-

Game cover containing kale and quinoa on our grey partridge recovery project site at Royston. (Malcolm Brockless)



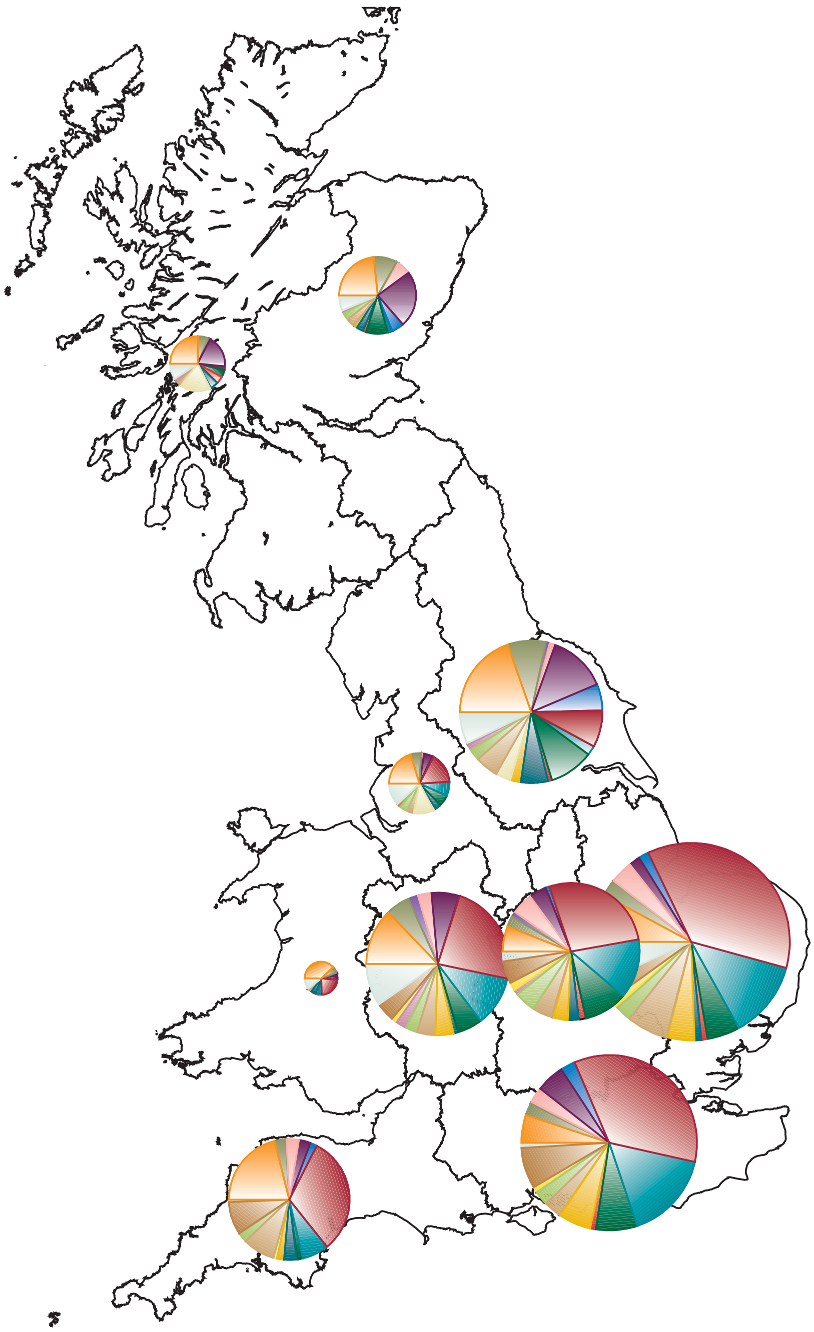


Figure 1

Relative area of game cover crops planted by participants in the GIS survey, divided into regions

etary pellets and triticale. Most food was provided in the south and west of England, where most game is released.

Of the estates, 80% planted game crops. Out of a total of 9,773 hectares of game cover crop, the most commonly planted crop was maize or a maize mix. Maize was most common in the south, kale and cereals in the north and kale in the west (see Figure 1). Using the amounts provided by the estates that returned detailed information, we can assess the value of these game cover crops to wintering farmland birds using reported densities of farmland birds on game cover crops and farmland in Britain (from Defra's Science and Research Project BD1606). Game cover area occupied, on average, 3.0% of the arable area within these estates, but provided a food resource for 14.5% of the farmland birds found within the estates, 4.8 times that provided by standard arable land. On the total arable area within surveyed estates of 318,296 hectares, this is equivalent to 17,000 extra farmland birds finding winter food on the game cover in comparison to what would have been there if this area had been managed as conventional arable land.

Parasite susceptibility of grey partridges in Norfolk

Key findings

- Increased parasitism among grey partridges caused by ants in the diet is less likely to cause a decrease in chick survival than a lack of food.
- Management should focus more on providing food for chicks than concentrating on effect of parasites.

Stephen Browne

In the mid and late 1990s a number of estates in East Anglia suffered successive years of poor breeding and their partridge stocks went into decline. Although the precise causes for this reduced breeding success are unknown, it coincided with increased reports of parasitic disease in wild birds. Consequently it was suggested that chick-food availability had become so low that grey partridge chicks were being forced to eat some insects that harboured internal parasites and spread disease. To establish whether diet and disease susceptibility had altered in recent years, we did a three-year study of wild grey partridges in East Anglia.

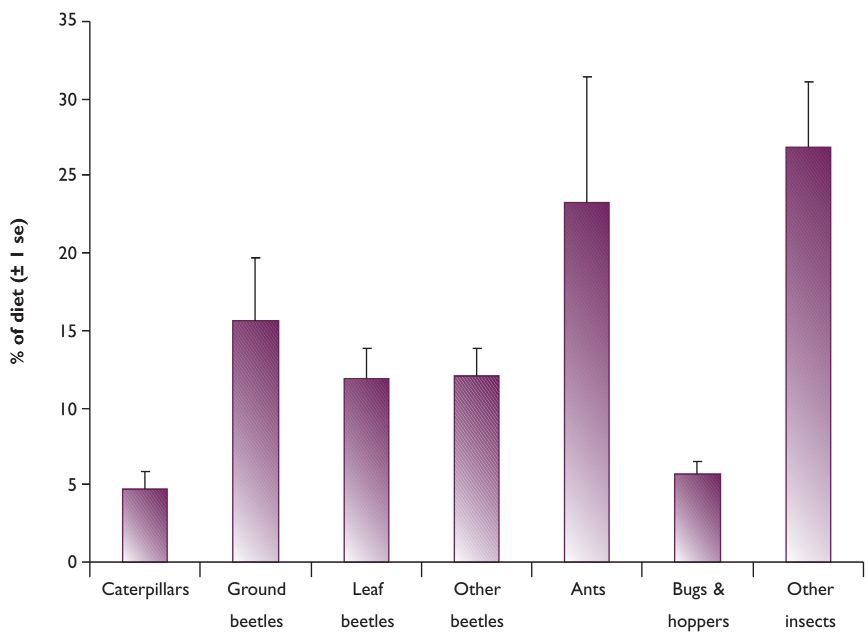
We caught 85 female grey partridges and fitted them with radio transmitters at three study sites in Norfolk with a history of high unexplained losses. We followed these birds through the breeding season and assessed their breeding success, survival and diet. We also did post-mortem examinations on all partridges found dead or in poor condition.

Among the radio-tagged birds, seven were killed by predators, six died as a result of disease and a further 11 died from a variety of other or unknown causes. Breeding success for the radio-tagged birds was low. Although 54 females laid clutches, only 34 actually hatched young and only 20 broods survived longer than six weeks. Analysis of faeces revealed that chick diet contained a range of insects that was typical of earlier studies (see Figure 1). However, we found that the chicks consumed more ants than usual. Ants, as well as several other invertebrates eaten by chicks at all sites, are known to be intermediate hosts of internal parasitic worms. The survival of chicks in a brood was, on average, inversely related to the percentage of ants in the diet (see Figure 2). In other words, the more ants eaten by the chicks, the lower the chicks' chances of survival. This may reflect increased disease susceptibility or perhaps a poorer diet. The post-mortem examinations of 79 birds showed that 33 of these contained nematode or cestode parasitic worms. However, only 14 (17%) of the autopsied birds had levels of parasites that were thought likely to have caused death.

Although we found that chick losses were highest where ants formed a high proportion of the diet, and although we cannot dismiss the possible effects of

Figure 1

The mean composition of grey partridge brood diet at three sites in Norfolk, 2001-2003



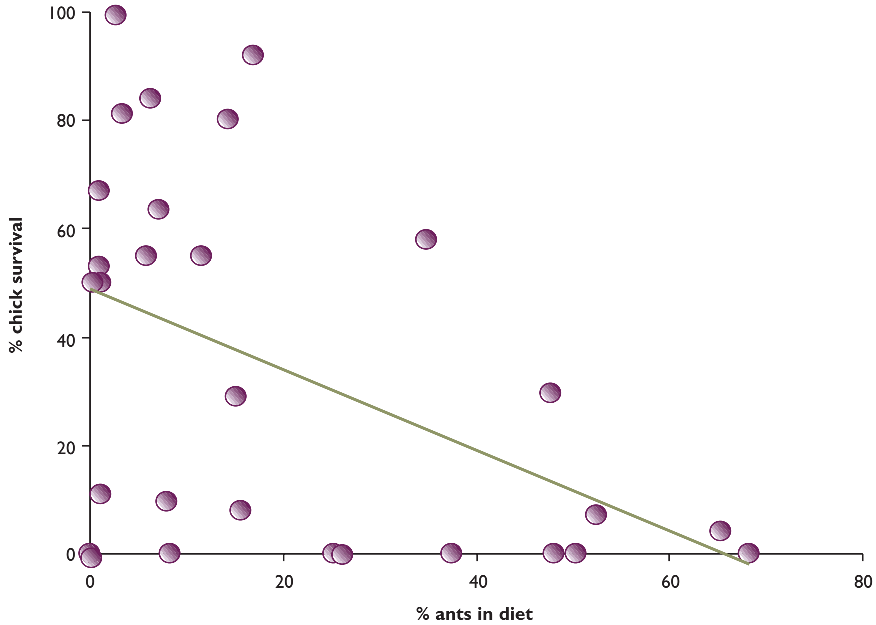


Figure 2

Relationship between the percentage of ants in diet and chick survival for three sites in Norfolk, 2001-2003

parasitic disease, we think that the apparent decrease in chick survival indicates a continued reduction in food availability for grey partridges over recent years, rather than an increase in parasitism. Accordingly, wild grey partridge management should aim at improving food availability for chicks rather than focusing only on the possible effects of parasites.

Young partridges eat a variety of invertebrate food. (David Mason)

Feeding experiment in Norfolk grey partridges

Key findings

- Chicks that were fed beetles, snails or ants (known to be potential carriers of parasites) did not contract parasites.
- Growth rates of chicks fed on beetles, snails or ants were higher than those fed just chick crumb.
- Reduced chick survival is more likely to be caused by lack of food rather than parasite infection.

Stephen Browne

In this study, we experimentally altered the food availability of reared grey partridge chicks to test whether the consumption of invertebrates known to carry parasitic worms caused increased parasitic infection in partridges.

We kept 20 batches of 12 one-day-old grey partridge chicks in captivity on a sterile substrate. We fed all batches with a standard diet of chick crumb but, for the first three weeks, we augmented the diets of 15 batches with ants, beetles and snails, which are all known to be vectors of parasitic disease. Five batches received adult ants, five a variety of small snails and five carabid beetles, with the remaining five batches receiving the standard diet as a control. We allocated the diet randomly to each batch. We also sealed the joints in the pens containing each batch and employed bio-security measures to prevent cross-contamination. In total, the experiment involved the collection and feeding of over 3,000 beetles, 3,000 snails and over 10,000 ants. We monitored the chicks and examined their faeces microscopically to confirm that the invertebrates had been eaten. In most cases chicks consumed all invertebrates within seconds of being fed them. We measured food (chick crumb) consumption and body size (wing length, body weight and tarsal length) daily and weekly, respectively. After six weeks, we conducted post-mortems on all chicks that had not died previously to establish the number and species of internal parasitic worms.

After receiving an augmented diet for three weeks and allowed to grow until six weeks old, none of the chicks fed an experimental diet contracted parasites. Although there was no difference in the amount of non-invertebrate food consumed by the different groups, the growth rates of chicks eating ants and beetles were higher, on average, than those of chicks eating snails or an unsupplemented diet (see Figure 1).

Across the batches and throughout the supplementary feeding part of the experiment, a huge number of invertebrates were fed. It is therefore very likely that the chicks were potentially exposed to parasites. Moreover, the quantity of invertebrates fed to the chicks supplemented the diet to such an extent that they grew better.

The black ant Lasius niger *can be a source of tapeworm infection. (Nigel Cattlin/Holt Studios)*

Two of our batches of grey partridges. (Stephen Browne)

The lack of parasitic infection shows that either the infection rate must be very low or that some other factor may be controlling the contraction of disease. Unlike wild grey partridges, the chicks reared under the experimental conditions had all the requirements for good growth, namely a permanent supply of warmth, light, water and a high-protein diet. It is possible that under these ideal conditions grey partridge chicks have a much better immunity to parasitic infection.

Our conclusion from the two studies looking at disease in wild grey partridges is that disease and the apparent reduction in chick survival is most likely to be the result of reduced food availability, rather than an increase in parasite infection.

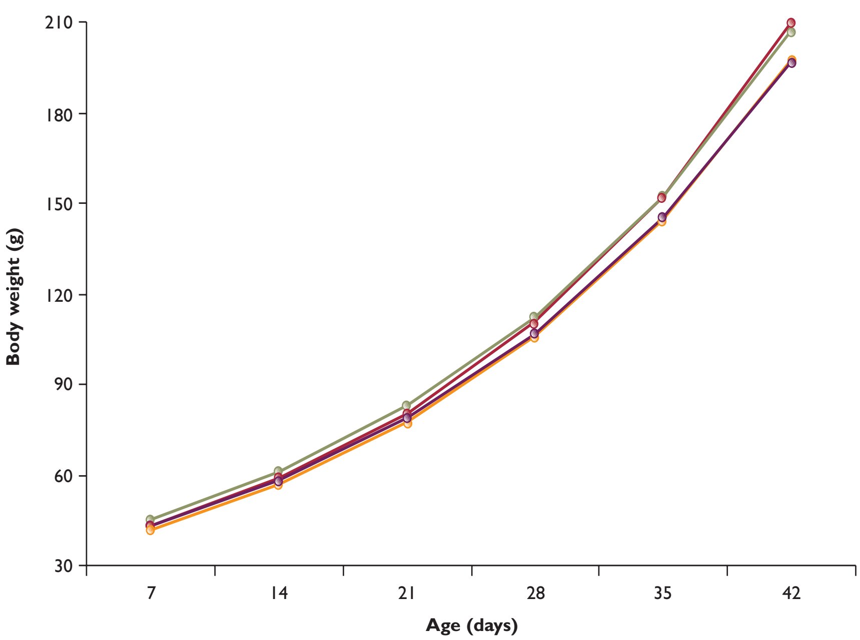


Figure 1

Growth curves for body weight (g) of grey partridge chicks reared on one of four diets

The effects of raptor predation on grey partridges

Key findings

- Female sparrowhawks were the most commonly seen raptor attacking or feeding on grey partridges.
- Grey partridges were not important in the diet of buzzards.
- The impact of raptor predation is highest at low grey partridge densities (below five pairs per 100 hectares).
- Many more grey partridges were shot in Sussex than were predated by raptors.
- The most important time for raptor predation of grey partridges was late winter.
- Losses to raptors can be reduced by providing tall cover in February and March.

Mark Watson

The work to identify the causes of the decline of the grey partridge, begun by Professor Sir Richard Southwood's work on Lord Rank's estate in the 1960s, and followed by Dick Potts' pioneering study in Sussex in the 1970s. These were done when raptors were either absent or scarce. Now grey partridges are at very low density with considerable gaps in their distribution, whereas lowland raptors, especially sparrowhawks and buzzards, are generally widespread and relatively common. In the late 1990s, our monitoring in the Sussex study area revealed a coincidence of raptor sightings with areas where grey partridges had declined the most (*Review of 1999*). Although seeing lots of raptors does not necessarily mean that they were eating the grey partridges, there was suggestive evidence that required urgent investigation.

Key questions:
1. Which raptors eat grey partridges?
2. What proportion do they eat?
3. When does predation occur?

Female sparrowhawks were the raptors most often seen attacking or feeding on grey partridges. (David Mason)

4. Does this reduce the population enough to cause decline?
5. If it is enough to cause decline, what can be done about it?

In Sussex, 12% of grey partridges were killed by raptors compared with 32% which were shot. (Mark Watson)

The project started by investigating raptor kill rates and the causes of local extinctions on downland in Sussex. It then developed into a study across 20 sites that contained different densities of raptors and partridges, spread across eight counties from Dorset to Lincolnshire. The aim was to gather information about partridge survival and habitat use from radio-tracking under different levels of raptor predation risk. We spent over 3,149 hours gathering data across 20 sites during the winters of 2000/01, 2001/02 and 2002/03.

Which predators were important?
Female sparrowhawks were the raptors seen most often attacking or feeding on grey partridges. Although buzzards were numerous at some sites, the data showed that grey partridges were unimportant in their diet, so it was unlikely that this species could be responsible for a large direct mortality of partridges. Peregrines and hen harriers both attacked grey partridges and were occasionally successful, but they were seen very infrequently.

When does predation occur?
Regular searches for partridge carcasses showed that most losses of grey partridges to raptors were in late winter. This was confirmed by an intensive study of sparrowhawk and buzzard diet in the breeding season conducted by Simon Smart, an MSc student at Reading University, who found the remains of a grey partridge only once in 73 prey items from five buzzard nests and 295 prey items from five sparrowhawk nests. Further, the collection date of partridge carcasses predated by raptors and sent in by gamekeepers for post-mortem examination showed a peak of losses in February and March. Clearly, late winter was the most important time for raptor predation.

How many partridges do raptors eat?
Two separate sources of data gave closely matching estimates of over-winter losses to raptors. The first was from autumn counts in Sussex, taking into account subsequent

Mark Watson surveyed birds of prey in Sussex. (Mark Watson)

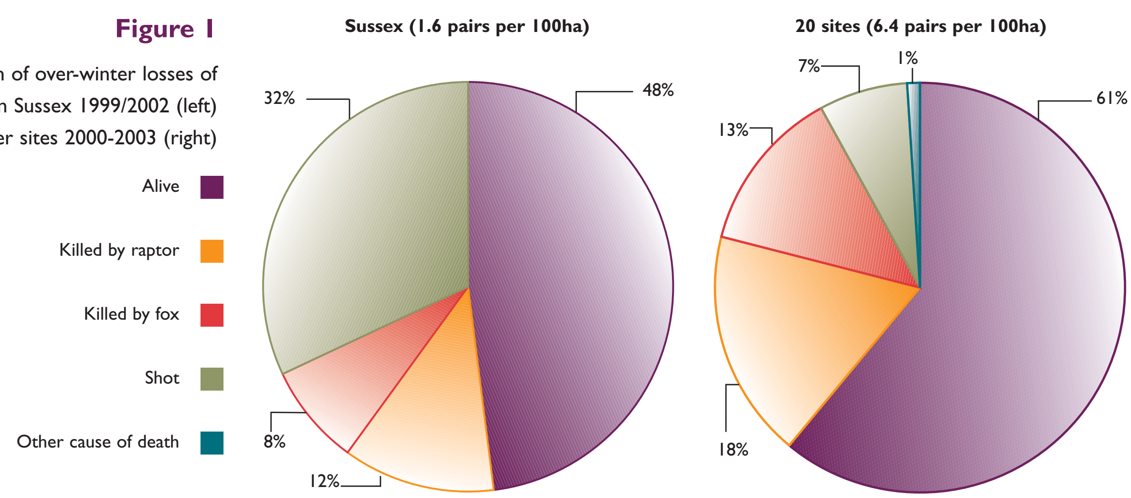
losses to shooting. The kill rate by raptors based on carcass searches and adjusted for fox scavenging suggested that 12% of the partridges counted in autumn were killed by raptors. The second data source was from radio-tagging 181 birds across 20 sites. This suggested that losses to raptors over winter amounted to 18% when adjusted for fox scavenging. For comparison, shooting losses were 32% in Sussex in 1999/2000 (since 2000, reduced to under 13% - see *Review of 2001*) and 7% across the 20 sites in 2000-2003 (see Figure 1).

Are losses to raptors enough to cause partridge decline?

Computer modelling suggested that, at low densities, this level of loss to raptors would result in a 39% reduction in average spring pair density over the long term. Because shooting losses occurred before the peak time for losses to raptors, the two causes of loss were largely additive. Shooting alone at 40% resulted in a 23% reduction over the long term in spring stocks, and shooting and raptors combined reduced spring stocks by 52%. Crucially, the impact of raptor predation was greatest

Figure 1

The pattern of over-winter losses of grey partridges in Sussex 1999/2002 (left) and 20 other sites 2000-2003 (right)



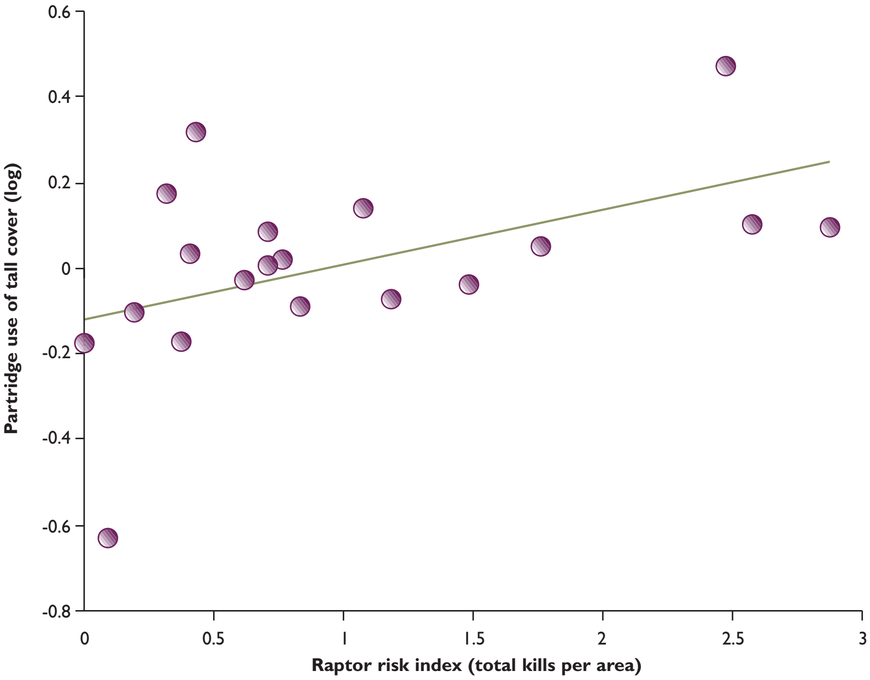


Figure 2

Partridges use tall cover when risk of predation by raptors is high

Note: the raptor predation risk index was calculated as the kill rate of birds including grey partridges at each of the 20 sites.

at low partridge density; above approximately five pairs per 100 hectares the impact was much less. The density in Sussex was 1.6 pairs per 100 hectares, and averaged 6.4 pairs per 100 hectares for the radio-tagged birds in the 20-site study.

Manipulating habitat and shooting

The habitat preferences of radio-tagged grey partridges showed that they used taller cover more when the risk of predation was greater (see Figure 2). Putting this together with the timing of peak losses of partridges to raptors, this means that to mitigate the impact of raptors, partridges need tall cover in February and March. Current practice is often to plough up cover crops at the end of the shooting season, ready for re-sowing in the spring. The implication is that it would be much better either to leave such cover until the end of March, or to sow biennial crops that maintain cover throughout late winter and spring. There are also clear advantages to boosting partridge density by enhancing nesting and brood-rearing cover, thus bringing their density above the threshold of vulnerability to raptor predation.

Declining species will have low tolerance to shooting if the population mechanism that compensates for shooting losses is disrupted. In the grey partridge, reduced productivity has had this effect, and over-shooting can extinguish the stock. Banning shooting is not a solution, as the decline would continue so long as its underlying causes were not addressed. These causes are changes to farming that have taken place in the last 50 years. The Curry Report and its proposal for farm subsidy to be directed partly towards conservation offers real hope. The resulting Entry Level Stewardship due to start in 2005 contains many features pioneered by the Trust, such as conservation headlands and beetle banks. It will be truly nationwide as, to receive the £30 per hectare subsidy, farmers will have to implement conservation measures from a large and flexible menu of options. To save the grey partridge, it is important that landowners, farmers and shoot managers take full advantage of the opportunities offered by Entry Level Stewardship. At the same time, they must avoid shooting any remaining wild stock of grey partridges, not least by taking special precautions during driven red-legged partridge and pheasant shoots. Our leaflet *Conserving the grey partridge* gives details of these and other conservation measures to help the species. It is available free of charge from the Trust.

We spent over 3,000 hours gathering data on grey partridges and raptors across 20 sites from Dorset to Lincolnshire. (Mark Watson)

Acknowledgments

We are extremely grateful for generous funding provided by Game Conservancy USA. More than 100 farmers and keepers helped with the study in very many ways – sincere thanks to all of them.

Learning from pheasant research in Austria

Key findings

- Predation rates of pheasants at Seefeld, Austria are similar to those at Loddington and Tendring Hall in the UK.
- Pheasant nesting success is lower at Seefeld than at Loddington or Tendring Hall.
- Two in three chicks survive at Seefeld, compared with fewer than one in three on typical managed wild pheasant estates in England.
- Chick-food insect availability is high at Seefeld, due to hot, dry summers.
- Minimal use of pesticides and careful siting of brood cover at Seefeld increases availability of insects for pheasant chicks.

Roger Draycott

In 2003 we completed the final year of our wild pheasant study at the remarkable Seefeld Estate in Austria, which has among the highest densities of wild pheasants on record. The study enabled us to investigate in detail the survival, nesting and brood-rearing ecology of the pheasants and to find out why they are so successful there. The results of the research are applicable to the way we manage wild pheasants in Britain because the estate is a 2,400-hectare efficient arable farming enterprise managed in much the same way as most large British lowland estates that have an interest in shooting.

In collaboration with the University of Georgia, USA, we have radio-tagged and monitored 127 hen pheasants during the last three breeding seasons. We have collected information on the habitat selection of the hens during the pre-breeding dispersal period, the mating and nesting season and during the brood-rearing period. We have studied the nesting success of the birds and the survival of hens and broods. We also collected data on the diet of chicks and availability of insect chick food in different habitats.

Over the three years of the study, 60% of the radio-tagged hens survived the breeding season. Of the 40% that died, the majority of deaths were due to fox predation during the egg-laying and brood-rearing periods, although very few hens were lost while actually incubating their clutch. The levels of fox predation were very similar to predation rates on managed wild pheasant estates in Britain. We monitored 89 nests in the study, the majority of which were in cultivated fields and set-aside land. Set-aside was the habitat chosen most for nesting when the relative areas of all the habitats are taken into account. The proportion of nests that hatched was 41%. In our radio-tracking studies in Britain, wild pheasant nesting success was 52% at Loddington (Leicstershire) and 49% at Tendring Hall (Suffolk). Of the nests that did not hatch, predation was responsible for the majority of losses. It is not surprising that nesting success was lower because there is a much wider variety of potential nest predators (both mammalian and avian) at Seefeld. However, after losing a nest, virtually all the hens attempted a second or third clutch.

Tom Bliss and Austin Weldon search for a pheasant brood in set-aside at Seefeld Estate in Austria. (Roger Draycott)

We monitored 20 different broods and analysed their survival, diet and habitat use. They spent a lot of their time in cereal crops, set-aside land and sown game cover. Considering the relatively small areas of set-aside and game cover available, these were the habitats that were strongly selected by broods. Detailed analysis of the brood home ranges enabled us to find out exactly which types of areas they chose. For example, although broods used reedy areas infrequently, many broods selected home ranges that contained reed grass. Perhaps they use it as potential escape cover from predators? This information can help us site and manage our brood-rearing covers more efficiently and highlights the importance of distributing brood-rearing cover around the farm. The average brood size was 5.9 and chick survival was 67%. In Britain, on managed wild pheasant shoots chick survival is typically around 30% (see Table 1).

It appears that it is the high number of surviving chicks that is responsible for the high pheasant density at Seefeld. Insects, on which wild pheasant chicks are dependent for the first two weeks of life, were abundant in game covers and set-aside. The higher numbers of insects are mainly due to the relatively hot dry summers that Austria experiences, but minimal use of pesticides and the careful siting and provision of brood-rearing areas no doubt increase the availability of insects for pheasant broods too.

Tom Bliss locating a nest of a radio-tagged pheasant on Seefeld Estate in Austria. (Roger Draycott)

Table 1

Breeding success of wild pheasants in Britain compared with Austria

	Britain	***Austria***
Hen survival (April to July)	50-60%	60%
Average clutch size	11	10
Nest success (percentage of nests hatching)	50%	41%
Chick survival	30%	67%

Wormer treatment aids pheasant breeding success

Key findings

- Pheasant breeding success was better among birds fed wormer-treated grain than those eating non-treated grain.
- There were 15-50% more chicks observed on the plots with treated grain.
- Spring wormer treatments can reduce worm burdens in pheasants and lead to higher breeding success.

Roger Draycott

In 2003 we completed the final year of our field trial investigating the impact of parasitic worms on the survival and breeding success of pheasants. In Britain, parasitic worm infection is widespread in pheasants, with the most common parasites being *Heterakis gallinarum*, gapeworm (*Syngamus trachea*) and *Capillaria* species. Our previous research on a single study site showed that these parasites can reduce survival and breeding success in pheasants. The parasites' eggs can remain viable in the soil for several years and can build up in areas where pheasants congregate, such as release pens, near feeding points and in holding woods. Our work with spring feeding (see *Review of 2000*), showed that the next logical step was to combine feeding with an anthelmintic dosing treatment to determine whether breeding success could be improved.

We started our field trial in 2000, with nine sites in Norfolk participating in the study. On each site we had two study plots, which were approximately 300 hectares each. In the first year we gave a wormer treatment to all pheasants. In the second and subsequent years in early spring we provided treated grain (treated with the worming drug, Flubenvet) to pheasants via feed hoppers in one of the plots on each site. Meanwhile we provided ordinary untreated grain in the remaining plots. We counted pheasant numbers in spring and autumn to assess survival and productivity and we counted parasites from birds collected each shooting season from each plot.

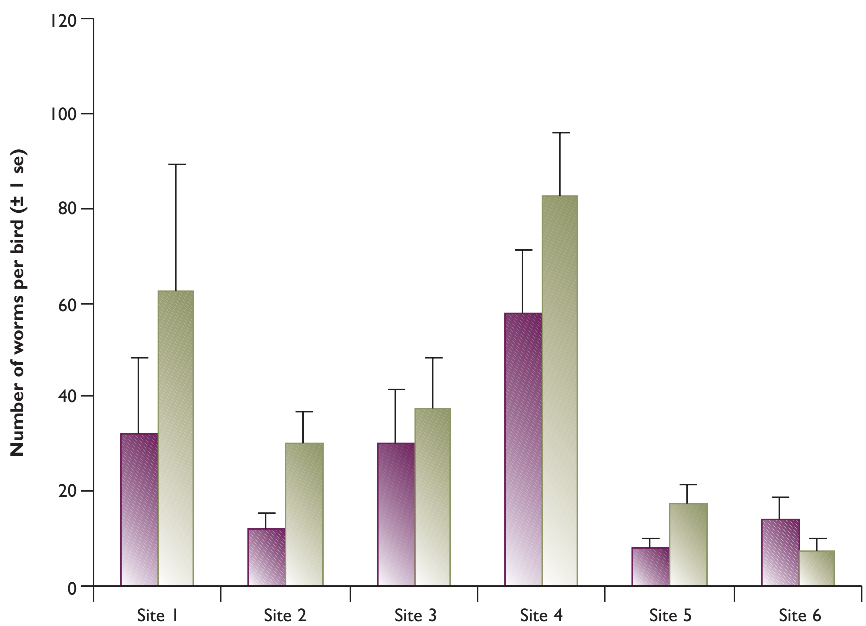
In April 2003, we placed parasite-free hen pheasants in pens in the treated areas (ie. where Flubenvet-treated grain was provided) and control plots, moving the pens twice weekly for 30 days to maximise exposure to the soil. We then conducted post-mortem examinations on the birds to check for the presence of parasites and assess the effect of the four-year treatment on environmental worm levels. Over 98% of birds were infected with *H. gallinarum*, 63% of birds were infected with *Capillaria* species and around 10% were infected with gapeworm. We did not find any evidence of tapeworm infection. These results reveal the high prevalence of the parasites in the environment. However, when we compared the worm burdens of the most prevalent and abundant worm, *H. gallinarum*, in birds held in treated versus untreated plots, there were significantly fewer worms in the treatment group (see Figure 1). In the birds collected in winter on shoot days, worm burdens were around 10% lower in birds from treated plots, although this difference was not significant. This was perhaps to be expected as we collected these birds nine months after treatment, allowing time for re-infection.

Figure 1

Burdens of *Heterakis gallinarum* in penned hen pheasants placed in plots where Flubenvet-treated grain was provided and untreated plots, April 2003

Plots with Flubenvet-treated grain

Untreated plots



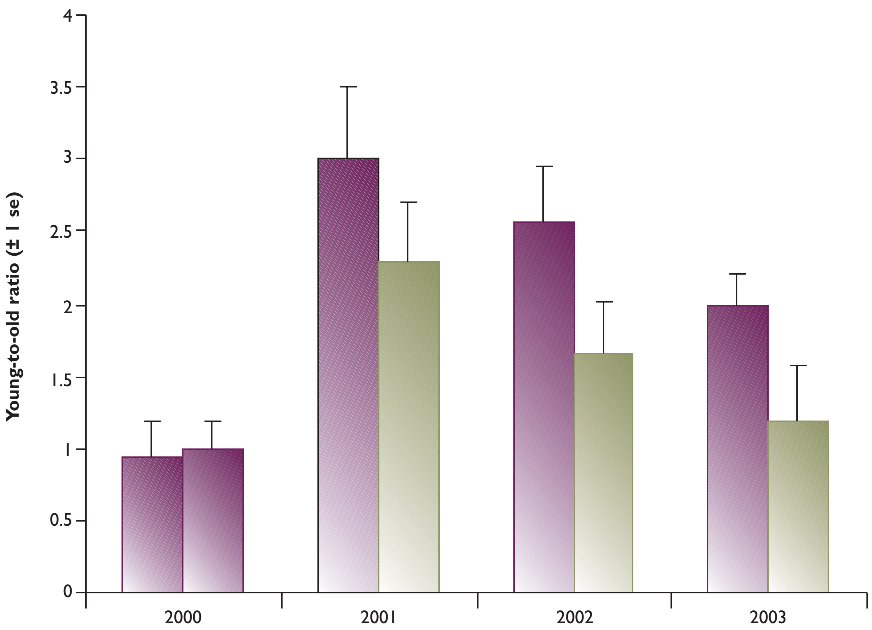


Figure 2

Productivity (young-to-old ratio) of pheasants in plots where Flubenvet-treated grain was provided and untreated plots

Plots with Flubenvet-treated grain

Untreated plots

Note: In 2000 feeders in all plots had Flubenvet added

The results from the game counts showed that breeding success (in terms of young-to-old ratio) was significantly higher in birds from the treated plots in 2002 and 2003 (see Figure 2). This improved breeding success resulted in between 15% and 50% more young birds observed in the treated plots. Our results show that in some situations a spring wormer treatment can significantly reduce environmental parasite burdens, which can lead to increases in pheasant breeding success. This research will help us to develop practical prescriptions for the control of parasites in free-living pheasants that can be used by gamekeepers and shoot managers.

Parasite-free pheasants were kept in pens to monitor parasite uptake from the soil. (Roger Draycott)

Careful release pen siting avoids woodland damage

Key findings

- The amount of bare ground decreases with increasing size of release pen.
- Plants of disturbed ground increase inside release pens as pheasant densities go beyond recommended levels.
- Species preferring shade decrease in pens as stocking goes up.
- Tree and shrub seedlings decline in older pens.
- These affects can be avoided or reduced by keeping stocking densities at recommended levels (around 700 birds/ha of pen).
- We recommend avoiding putting pens in ancient semi-natural woodland containing valuable native shade-tolerant perennial floras.

Rufus Sage

In this study we aimed to show whether plant communities in areas of woodland enclosed by pheasant release pens were different to those found in other parts of the same woodland. We did the study in the southern half of England and confined it to ancient semi-natural woodland sites. These woodlands are valuable habitats for wildlife and an important part of our cultural heritage.

We used replicated quadrat surveys of ground flora species and structure in a sample of 43 release pens in ancient semi-natural woodland and 43 (paired) control plots. We did this in spring/early summer, to ensure that any changes detected were not just seasonal (ie. just following release). We also investigated the extent to which any effect might be related to the stocking density of the pen, pen size or pen age.

We did the original field work back in 1988 and wrote it up in a report for English Nature and an article for our own *Review of 1988*. Since then, the work has become increasingly topical as part of our programme of research on effects of pheasant releasing (see *Review of 2002*). An inspection of the original field sheets suggested that there may be more to the data than originally thought, so in 2003 we did a more sophisticated analysis of the 1988 data, which has revealed some important new relationships for the first time.

The sample of 43 release pens ranged from one to 20 years in age. The average pen size was 0.5 hectares and the average stocking density was 2,100 pheasants per hectare of pen. Since 1988 pen sizes may have increased and densities decreased. Overall, the release pens had more bare ground and less vegetative cover from 0 to 10 centimetres off the ground in the spring than the control areas. Bare ground was most evident in smaller pens (see top left graph in Figure 1).

Overall, plants of fertile or disturbed ground (see Table 1) were significantly more common in release pens than control plots. However, these species only increased in

Figure 1

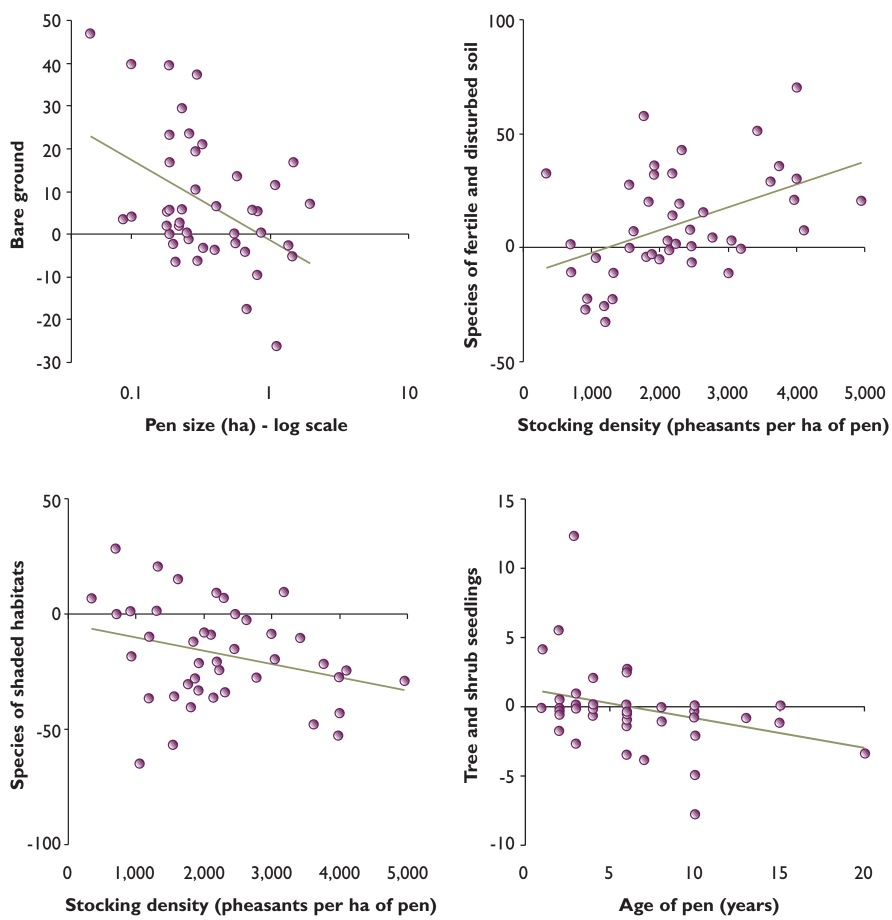
Top left: Amount of bare ground in relation to pen size

Top right: Species of fertile disturbed soil in relation to stocking density.

Bottom left: Species preferring shade in relation to stocking density

Bottom right: Tree and shrub seedlings in relation to age of pen

Note: each point represents a separate site. For each graph the vertical axis is the percentage difference between the pen plot and the control plot at a particular site, so positive values mean more of that measure of the ground flora in the pen than in the control and vice versa. Regression lines are all statistically significant at P<0.05.



percentage cover as stocking density increased above a certain level. At densities below around 1,000 birds per hectare, the establishment of these (sometimes undesirable) species will not occur (see top right graph in Figure 1).

The release pens, however, had fewer species overall and this was due to a reduction in the percentage cover of shade-tolerant perennials characteristic of old woodland sites (see Table 1). The number of these important woodland plants reduced further as stocking densities went up. At densities below around 1,000 birds per hectare, these effects are minimised, but still occur (see bottom left graph in Figure 1).

Tree and shrub seedlings were not common in most of the pen or control sites in the study. This a problem for many lowland woods, particularly where deer are numerous. Where these seedlings did occur, their abundance was further reduced by the presence of a release pen. This time the reduction was related to the age of the pen (see bottom right graph in Figure 1). Bramble, the most abundant species in the study, was also less common in release pens.

We have documented many of the benefits to woodlands of releasing pheasants in cases where a principal aim of the game manager is to encourage shrubby cover and open areas for pheasants through coppicing, skylighting, ride widening and so on. Although we have identified release pens as a possible source of conflict which, when managed badly, can negate the benefits in sensitive woodlands, the work also indicates that by implementing good practice these conflicts can be avoided. In particular, we believe it is best to avoid areas of ancient semi-natural woodland containing a valuable native shade-tolerant woodland flora when considering a new pen site. We recommend maintaining stocking densities at recommended levels by restricting the number of birds released, maximising the pen size, or both. We are currently expanding our research to produce detailed recommendations.

Table 1

Common plants in pens

Preferring fertile or disturbed ground

Plants	*Pen*	*Control*
Creeping thistle	4	2
Cock's-foot	11	6
Cleavers	16	17
Hogweed	3	0
Yorkshire fog	7	3
Annual meadow grass	14	3
Creeping buttercup	2	6
Dock	9	1
Chickweed	15	7
Common nettle	27	22
Lords and ladies	9	14
Yellow archangel	9	18
Wood millet	2	9
Rough meadow grass	35	30

Preferring shady conditions

Plants	*Pen*	*Control*
Wood anenome	11	13
Lords and ladies	9	14
False brome	4	7
Pignut	4	3
Wood avens	6	21
Ground ivy	8	22
Ivy	2	4
Bluebell	27	26
Yellow archangel	8	17
Wood melick	5	5
Dogs mercury	29	30
Wood millet	2	9
Wood sorrel	3	7
Lesser celandine	5	6
Wood speedwell	5	8
Dog violet	6	14

The numbers are sites from the sample of 43 at which species were recorded in the pen or control area.

Is yours an ancient semi-natural woodland?

Inventories of ancient semi-natural woodland are available from English Nature and other national conservation agencies.

The wood anenome is a plant that may be damaged within release pens, although it is not the most affected of the shade-loving species. (Rufus Sage)

Fate of released pheasants

Key findings

- 25% of released pheasants died before the shooting season began.
- Most predation was due to foxes.
- 37.5% of released pheasants were shot on (or off) the estate.
- 16% of released pheasants survived until after the shooting season.

Clare Turner & Rufus Sage

This study was designed to document the mortality of released pheasants in relation to the density or scale of the release and the quality of the local habitat and its management. This is part of a larger on-going study looking at dispersal, which will be reported next year. We undertook fieldwork at six large releasing estates in southern England over the last three years.

The study used six open-topped release pen sites, three with poor and three with good local habitat quality. We varied the size of the release each year, but we kept other management components, in particular predator control and feeding, constant from year to year.

We fitted a sample of 25 to 30 birds in each release pen with radio-tags two to three weeks after release into the pens. Then, using a radio receiver, we located them several times each week over the pre-shooting period and during the shooting season and recorded their fate.

The study sites represent estates releasing 8,000 to 28,000 birds over 700 to 2,000 hectares, with one or usually more full-time professional gamekeepers managing the pheasants. The study pens are in the range 0.2 hectares to 1.4 hectares, normally containing between 400 and 1,200 pheasants, but up to 2,000 as part of our study of density.

The overall survival of 325 radio-tagged, hand-reared pheasants is shown in Figure 1. Steady losses, due mainly to predation, occurred between the time of release in July/August and the start of shooting in late October or early November, with 75% of the radio-tagged birds surviving until shooting began on the estates. Before shooting started, the rate of mortality dropped but, unsurprisingly, the number of birds dying then accelerates during the shooting season, so that by the end of the season, around 15% of birds remained alive. Although the pattern of survival varied at each of the six study sites, the data provide a useful insight into the overall survival of hand-reared pheasants released in the UK. Differences in mortality between estates were not related to the density or scale of the releases.

Many released pheasants do not make it through to the shooting season. Death can result from a number of causes. (David Mason)

One of the pheasants eaten by a fox. You can make out the radio-antenna beside its wing and its red wing tag. (Clare Turner)

The actual fate of the pheasants (see Table 1) shows that, overall, shooting was the cause of death for 37.5% of the radio-tagged pheasants, with predation being the next biggest reason for loss (although one estate lost 75% of the stock in one release pen in one year to predators). Of the tagged birds, 23% were predated or scavenged- the great majority by foxes - before shooting began (a figure comparable to birds in the wild). A further 13% were predated or scavenged during the shooting season (some of which may have been shot but not picked up). Of the 486 radio-tagged birds, we think three were killed by raptors. Disease and accidental deaths, such as collisions, also resulted in death of around 10% of the birds studied.

In addition to documenting the general survival trends and causes of mortality in released pheasant populations, this study has also generated large quantities of data concerning the movements and dispersal of pheasants. Once we have analysed the data fully in 2004, we hope to have a better understanding of the role played by density or scale of the release, and the quality of local habitat on both the survival and dispersal of released pheasants.

Table 1

Fate of released pheasants

Fate	*Mean %*
Early pen death	3.5
Shot within estate	30.5
Shot off estate	7.0
Predated/scavenged before shooting	23.0
Predated/scavenged after shooting began	13.0
Other death	7.0
Survived	16.0

Early pen death: *disease, accidents, etc.*
Predated: *mostly by foxes*
Scavenged: *died of other causes before being eaten by foxes*
Other: *mostly road kills*

The study followed, on average, 27 radio-tagged pheasants from six release pens on six estates in each of three years.

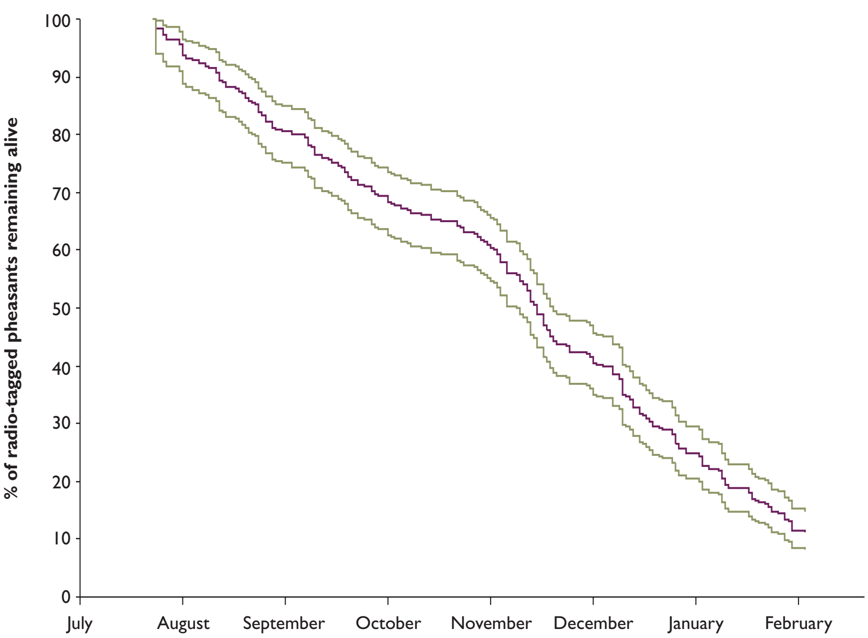


Figure 1

Survival of 325 radio-tagged pheasants after release into open-topped pens

— Survival

— 95% confidence interval

Woodcock - developing calibrations for the survey

Key findings

- It is possible to use observations of roding male woodcock to estimate the number of individual males.

Andrew Hoodless

In the latest review of the population status of birds in the UK, published in 2002, the woodcock was 'amber-listed' as a bird of conservation concern because of an apparent long-term decline in breeding numbers. However, to date, available information has consisted of incidental sightings of woodcock during the course of general bird surveys, rather than counts from surveys specific to woodcock. Records from our National Gamebag Census suggest no decline in the numbers of woodcock wintering in Britain, but the vast majority of woodcock shot here are migrant birds from Scandinavia and Russia and hence a problem within our resident breeding population, if there is one, will not be evident in our data.

In 2003 we did a large-scale survey of breeding woodcock, based on counts of roding males at dusk, in conjunction with the British Trust for Ornithology. 'Roding' is the display flight of males during the breeding season. The aim was to produce population indices for England, Scotland and Wales, against which future survey estimates could be compared. We randomly selected survey locations stratified by region and woodland area. Here we describe our work to validate the survey method, and will report on the survey results after full data analysis in 2004.

Female woodcock remain in woodland during the breeding season and their cryptic plumage, together with the fact that their nests are not easily located, means that counts of breeding females are not feasible. The males, however, become more conspicuous during the breeding season when they rode at dawn and dusk, but counts of roding males are difficult to interpret because a few dominant males rode for long periods each day and mate with most of the females, whereas other males only rode for short periods. Therefore, to use counts of roding males as a measure of abundance, it is important to establish the relationship between numbers of individual males and numbers of observations, and to check for differences between regions and habitats.

At a sample of 47 sites, about half in Durham and Northumberland and half in Hampshire and Wiltshire, we recorded the calls of all displaying birds with a sensitive microphone and analysed these using computer software to produce sonograms (plots of call frequency against time). The first step was to examine just one call from each site so that we knew each call was from a separate male. Based on differences in the 'squeak' element of the call, we found that individual males had distinctive, recognisable calls (see Figure 1). Once we had analysed all the calls from each site, we

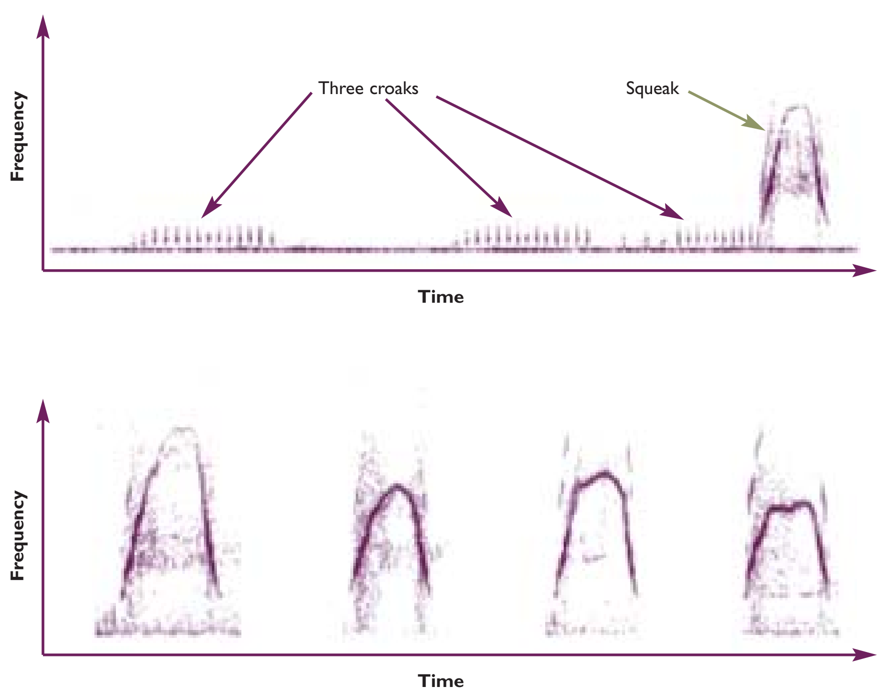


Figure 1

Top: Sonogram of a typical woodcock roding call, consisting of three low frequency 'croak' elements followed by a much higher frequency 'squeak' note

Bottom: Examples of 'squeak' notes from four different woodcock

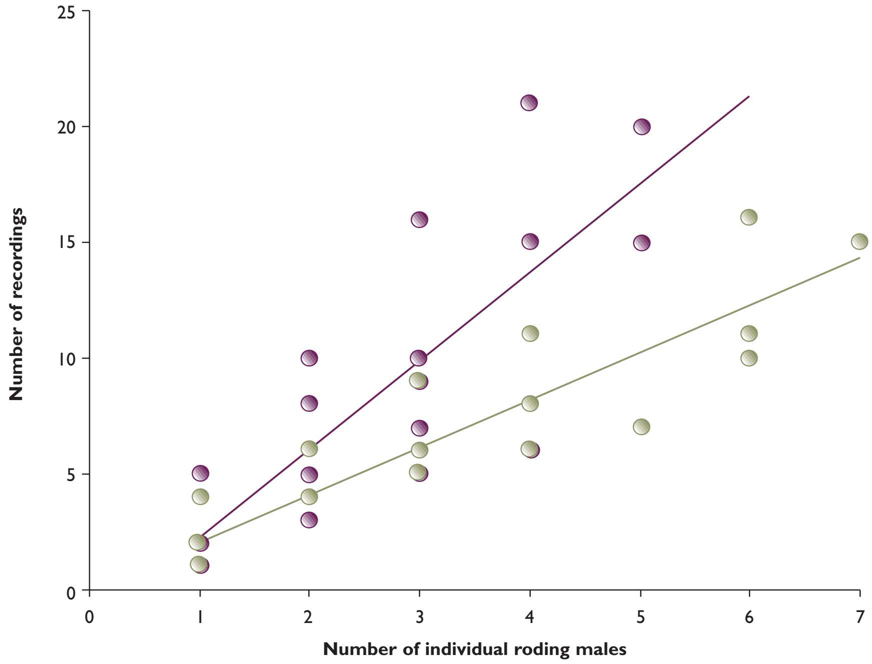


Figure 2

Relationship between the number of recordings made and number of individual roding males

Durham and Northumberland (21 woods)

Hampshire and Wiltshire (26 woods)

could plot the number of separate individuals against the number of recordings or the number of roding observations at each site. This showed different linear relationships between northern and southern England. For a given number of roding males more recordings were likely at sites in the north (see Figure 2). The difference could not be explained by differences in stand type (deciduous, mixed or coniferous) or date. It is probably related to the longer twilight period in the north, which enables roding to continue for longer. For the national survey we therefore limited the count period to one hour.

We now have good evidence that counts of roding woodcock will enable us to assess the status and trend of our resident birds in the future. We expect the results of the national survey in 2003 to highlight regional patterns in woodcock distribution and habitat use, which should enable us to give better management advice.

We are grateful to the Shooting Times Woodcock Club, the Wildlife Habitat Charitable Trust and an anonymous English charitable trust for funding this work.

Above: Jean-Philippe Doucet recording the calls of roding woodcock. (Andrew Hoodless)

Left: With their cryptic plumage, it is not feasible to count nesting woodcock. (Andrew Hoodless)

ESA helps some waders in the Avon Valley

Key findings

- Lapwings and redshank are more likely to breed on land managed under the higher ESA tiers than on non-agreement land.
- The future of lapwings and redshank in the Avon Valley will depend on uptake of ESA measures.
- There is no evidence that ESAs are benefiting snipe.

Andrew Hoodless

The Avon Valley floodplain between Salisbury and Christchurch is recognised for its breeding waders. About 52 square kilometres are designated as an Environmentally Sensitive Area (ESA) and five areas have Site of Special Scientific Interest (SSSI) status. By 1990, the valley was one of just eight lowland wet grassland sites in England that had retained appreciable numbers of lapwings, redshank and snipe. Nevertheless, survey data collected by RSPB, MAFF (now Defra) and ourselves in 1990 and 1996 showed declines of around 50% in pairs of lapwings and redshank, and 80% in numbers of displaying snipe. There was also a reduction in the area used by the birds, with a concentration towards the southern end of the valley.

Problems seem to be the drying out of fields in the spring, the loss of muddy ditch edges and an increasing polarisation in sward heights, with some swards too short as a result of intensive grazing and others too tall owing to encroachment by nettles, thistles and docks. These factors were addressed in revisions to the ESA scheme in 1998. There is now a breeding wader supplement to the permanent grassland tiers (tiers 1A and 1B), which provides an incentive for farmers to reduce stocking densities to 0.75 livestock units per hectare during April-May. There is also a new wet grassland tier (tier 1C) with a higher rate of payment for the removal of livestock during April-May combined with the retention of surface water in spring and maintenance of ditch water levels.

Historically the Avon Valley has been an important site for breeding waders. (Andrew Hoodless)

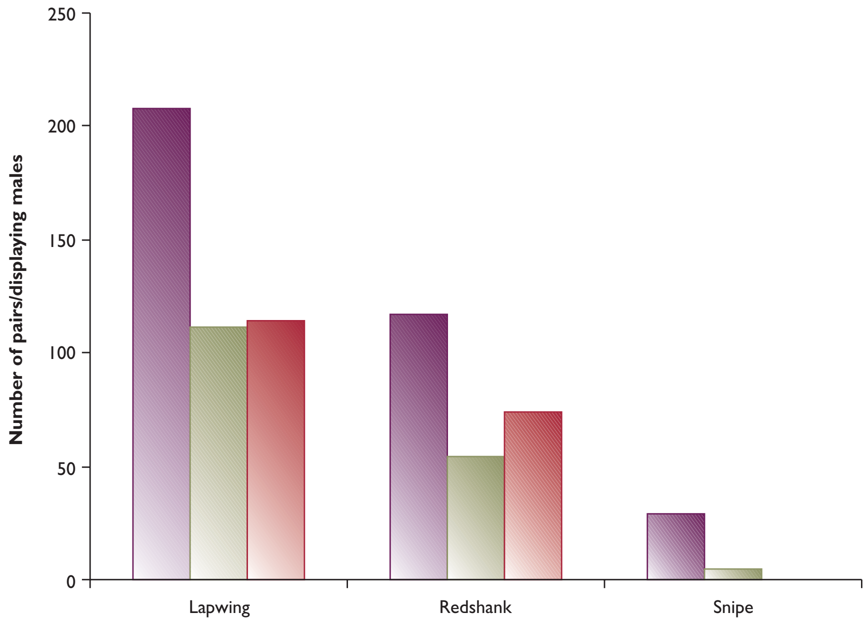


Figure 1

Comparison of numbers of breeding pairs of lapwings and redshanks and numbers of displaying snipe on the same farms in the Avon Valley between Salisbury and Christchurch in 1990, 1996 and 2003. The total area surveyed was 13 square kilometres (1,300 hectares).

1990

1996

2003

During spring 2003, Andrew Hoodless and Hannah McLaughlin (Reading University) repeated the survey of breeding waders to determine their current status and to assess the effectiveness of ESA prescriptions. They surveyed 28 sites covering an area of 13 square kilometres for a direct comparison with the survey data from 1990 and 1996. Our results were encouraging for lapwings and redshank, which showed no decline since 1996 (see Figure 1). There were some changes in the distribution, which could largely be explained by the management at each site. Lapwings and redshank were more likely to breed on fields managed specifically for breeding waders under the ESA scheme than on other permanent grass fields.

November-January 1995/6 was quite dry and could have reduced food for waders at the start of the breeding season, whereas in spring 2003 conditions were better and more pairs of birds may have settled as a result. The future of lapwings and redshank in the valley will probably depend on increased uptake of the ESA scheme. Further work is needed to look at breeding success of these birds.

The outlook for snipe looks bleak. We saw no drumming males in 2003 and flushed only five birds in May or June, suggesting that few birds had bred. In 1990, 29 displaying males were recorded on our study areas, but we saw only five in 1996. Sadly this picture is the same at other lowland wet grassland sites and there is no evidence that ESAs are benefiting this species.

Above: Snipe have not benefited from the Avon Valley ESA scheme. (Andrew Hoodless)

Left: Lapwing numbers have remained stable in the Avon Valley since 1996. (Andrew Hoodless)

Gamebird health summary for 2003

Key achievements

- Our rearing field became fully operational allowing us to combine studies of free-living and captive birds.
- Research into *Hexamita* produced interesting results (see page 82).
- Useful findings took us forward in our *Mycoplasma* understanding (see page 84).

Chris Davis

2003 began with a nation-wide discussion on how to rear birds without the medication Emtryl. The gamebird industry addressed many of the complicated management issues and, thanks to good weather and some medication, albeit in limited supply, 2003 was probably one of the best rearing seasons of late.

In general, disease levels were low, certainly in regard to infections with *Hexamita* (*Spironucleus*); this has meant that our research at Cambridge University was hampered by the lack of clinical material. There were, however, some isolated pockets of infection notably in Scotland and parts of the West Country. We even managed to diagnose *Hexamita* infection on our rearing field at Fordingbridge. Those birds affected were part of a study looking at the effects of bitting. We placed the birds on electrolytes, deaths ceased almost immediately and the problem disappeared. The outbreak was almost certainly related to a spell of exceedingly hot weather. However, the fact that birds in similar circumstances (in the same study) were unaffected demonstrates that the nature of this disease is complex.

Even lower supplies of Emtryl will be available in the 2004 season and we may have to cope with adverse weather conditions as well. We need to learn from the lessons in 2003 and build on them.

Coccidiosis infections were common in 2003, which is surprising as it is normally associated with cool damp conditions. We will need to pay more attention to coccidiosis in the future as the use of preventative drugs in the feed is under review and we have only a limited number of compounds available for its treatment.

Late autumn brought a spate of outbreaks of mycoplasmosis especially in the south of the country. Mature pheasants in the wood were affected by classic bulgy eyes and in some cases by a dramatically swollen head. At this stage all one can do is cull all the affected birds in the hope of reducing cross-infection. The use of drugs is not an option.

2003 saw the rearing field return to useful trials. Studies have included looking at welfare aspects of bitting, the effects of anthelmintic regimens on *T. tenuis* infection, and management studies of nutrition. We can now combine field and controlled studies in multi-disciplinary research programmes.

The rearing field at Fordingbridge, which became fully operational in 2003. (Sophia Miles)

Placing a leg ring on a pheasant on the rearing field. (Sophia Miles)

Gamebird welfare research in 2003

Project title	Description	Staff	Funding source	Date
Gamebird health	*Disease prevention and control in game and wildlife*	*Chris Davis, Des Purdy*	*Research Funding Appeal*	*1998 - on-going*
Hexamita	*Investigating the pathology and epidemiology of Hexamita in reared gamebirds*	*Chris Davis, S Lloyd (Camb Univ)*	*Lord Iliffe Charitable Trust Roxton Bailey Robinson*	*2000-2004*
Mycoplasmosis	*Investigating* Mycoplasma *as a respiratory disease agent in reared gamebirds*	*Chris Davis, J Bradbury & A Forrester (Liverpool Vet. School)*	*Research Funding Appeal National Gamekeepers' Organisation*	*2002-2004*
Bacteria in garden birds	*Monitoring frequency of disease pathogens from garden bird mortalities*	*Tom Pennycott (SAC Veterinary Science Division, Auchincruive)*	*Dulverton Trust, Core funds*	*2000-2004*
Bitting	*Looking at the effects of bitting on the performance and welfare of gamebirds*	*Des Purdy, Game farmers*	*Core funds*	*2003*
Trichostrongylus tenuis *in grey partridges*	*Looking at the effects of anthelmintics in the treatment of* T. tenuis *infection in grey partridges as a model for red grouse*	*Des Purdy*	*Core funds*	*2003*
Vaccines for Mycoplasma	*Assessing practical safety of using a commercial live* Mycoplasma *vaccine in juvenile pheasants*	*Des Purdy*	*Core funds*	*2003*
Electrolytes in gamebirds	*Safety and efficacy of electrolyte usage in gamebirds*	*Des Purdy*	*Core funds*	*2003*
Feed supplements in game rearing	*The role of feed supplements in rearing young gamebird chicks*	*Des Purdy*	*Core funds*	*2003*
Feed and water	*Utilisation of feed and water in gamebirds*	*Des Purdy*	*Core funds*	*2003*
Growth rates	*Measuring growth rates among gamebirds*	*Des Purdy*	*Core funds*	*2003*

Glucose key to understanding *Hexamita*

Key findings

- Transmission is most likely through faecal contamination, not through cysts harboured in the ground.
- Blood biochemistry suggests that the birds are in a state of effective starvation.
- Developing glucose and electrolyte solutions for oral administration may be a way of combatting the effects of the disease.

Chris Davis

Hexamitiasis caused by infection with the organism *Hexamita meleagridis* (*Spironucleus*) remains the major disease affecting reared game birds. Both pheasants and partridges suffer from this condition although the syndromes observed in the two species differ in some important aspects. The disease is probably the major cause of mortality in gamebirds during the rearing and immediate post-release period.

This article reports on work carried out by Dr Sheelagh Lloyd at Cambridge University Veterinary School during 2003. Some of the following are only preliminary findings as the data are still to be analysed in full.

From the start the life-cycle of *Spironucleus* has remained uncertain, early workers assumed and some reported a cyst-like stage that would allow the organism to survive in the environment between hosts. Such a stage would explain the fact that field reports suggest that some release pens cause repeated problems and others appear disease-free. During our studies hundreds of faecal smears and smears of the small intestine stained with giemsa have been examined and no cysts have been found.

In limited clinical observations, birds entering pens with damp areas that had housed infected birds 0 to two days previously became infected. Birds did not become infected if the pens had been empty for five days, suggesting that any infective form has a relatively limited survival time outside the host bird. The absence of a cyst is consistent with the fact that *Trichomonas,* a similar type of organism, does not form cysts and yet readily transfers between gamebird populations. The single 'cyst' seen in our early work must have been an artefact. This supports the theory that transmission of the disease is by the ingestion of contaminated faecal material.

In previous years we thought that there might be some association between several disease-causing organisms. Our findings, however, were not consistent. No other organism has consistently been found in pheasants, tending to confirm the importance of *Spironucleus* as a primary pathogen in this species. In partridges, however, it seems that birds are far more likely to show disease if they are concurrently infected with *Eimeria* coccidia.

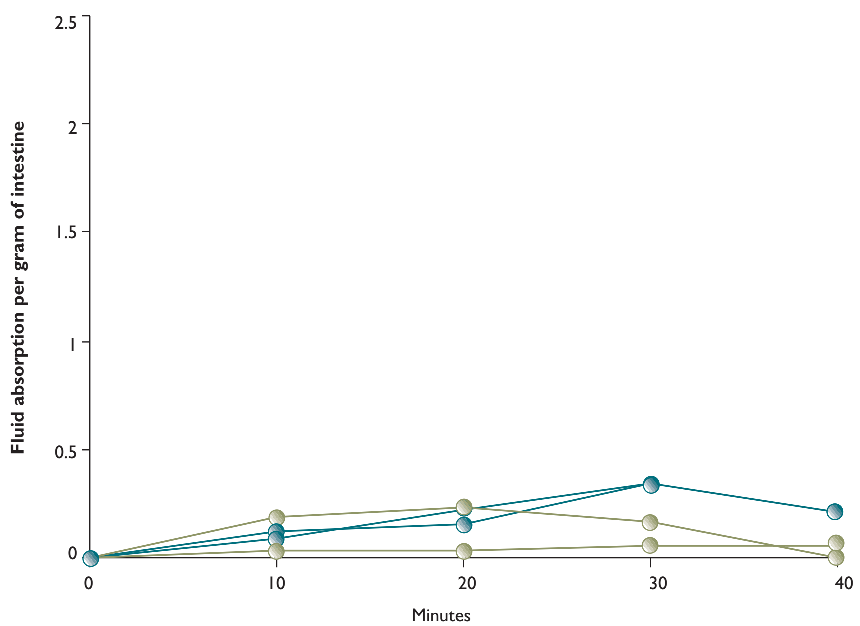
Throughout our studies we have been constantly surprised at the apparent lack of pathological changes, even in severely affected birds. Birds heavily infected with *Spironucleus* tend to demonstrate depression, diarrhoea and severe weight loss, often being described as 'knife-boned'. Blood biochemistry suggests that the birds are in a state of effective starvation. In the absence of obvious physical damage to the intestine we were interested in studying the absorption across the gut to see if this was adversely affected or could be manipulated to provide a 'cure' for the condition.

Figure 1

Fluid absorption across four sections of gut from a pheasant severely infected with *Hexamita*

Gamebird solution with double glucose

Standard gamebird solution



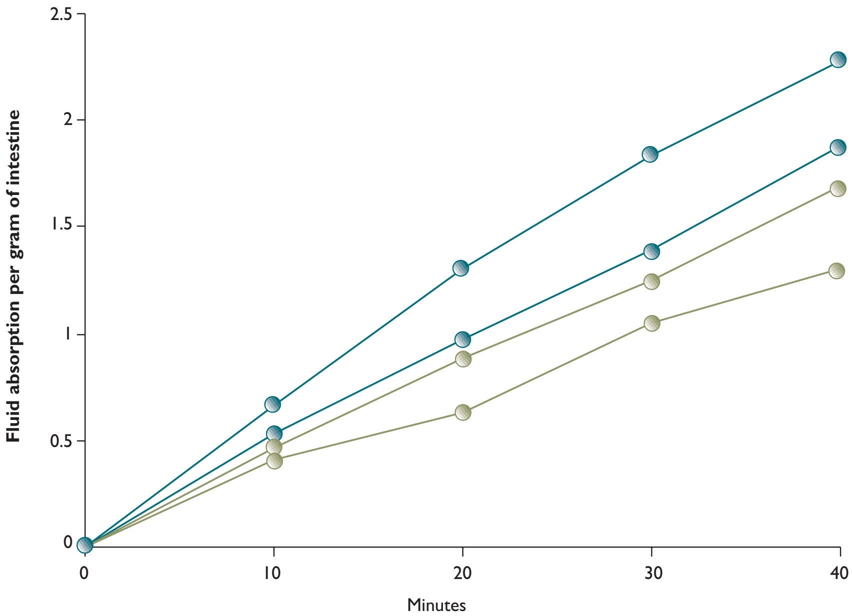


Figure 2

Fluid absorption across four sections of gut from a healthy pheasant

Gamebird solution with double glucose

Standard gamebird solution

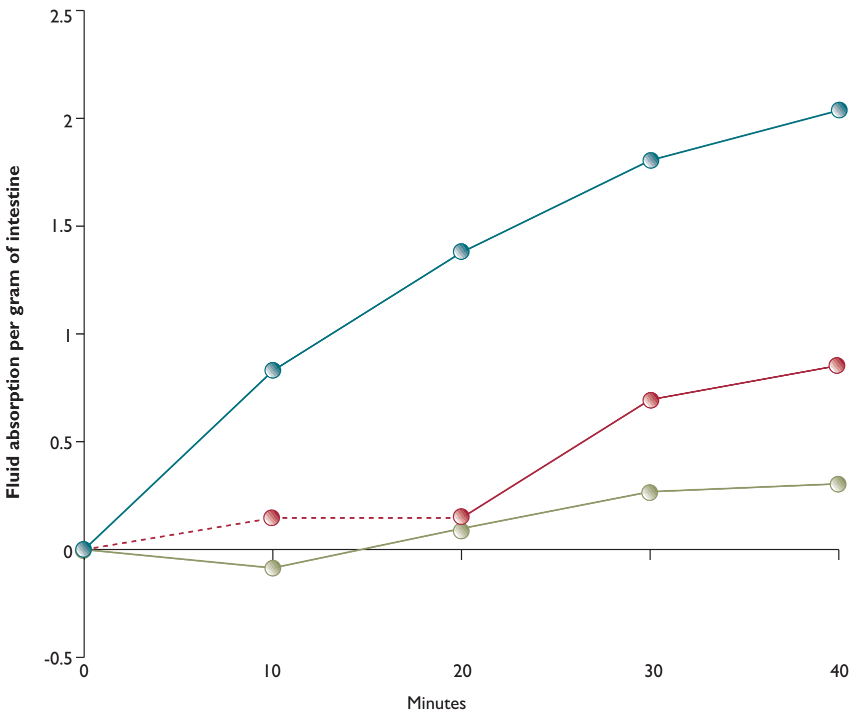


Figure 3

Fluid absorption across three sections of gut from a pheasant moderately infected with *Hexamita*

Gamebird solution with double glucose

Standard gamebird solution (dotted line) changing to double glucose (solid line)

Standard gamebird solution

Segments from the intestine of birds, taken within minutes after death, were turned inside-out and bathed in a variety of test solutions. The segments were periodically weighed and absorption was measured by the weight gain achieved over time. These studies indicated that absorption of a specially-designed gamebird electrolyte solution was usually poor in very heavily-infected birds (see Figure 1) but good in many moderately to lightly infected birds (see Figures 2 and 3). By manipulation of the constituents of the fluid, absorption could be altered in both normal and heavily-infected birds. Deprivation of sodium and glucose prevented absorption across the intestine, but doubling the glucose levels was very effective in increasing absorption. This could be mimicked in both normal and infected intestines deprived of glucose and then incubated in increased glucose buffer. We have long suggested that, at a very minimum, infection with *Spironucleus* and their associated frenetic activity must deprive the host of vital glucose supplies. Could this indeed be part of the story? Increasing the levels of the amino acid glycine also appeared to have a good effect, although this needs to be tested further.

We hope that this work will lead to recommendations that will greatly reduce the serious losses due to hexamitiasis.

When pheasants are only moderately infected with Hexamita*, glucose can help increase absorption through the gut and combat dehydration. (David Mason)*

Mycoplasma and respiratory disease in gamebirds

Key findings

- In gamebirds, the sensitive PCR test for *Mycoplasma gallisepticum (Mg)* is much better than the RSA test.
- It is possible for a pheasant to be carrying *Mg* without giving a positive RSA test.
- *Mg* is a definite pathogen causing respiratory disease in gamebirds.
- Corvids are not common hosts for *Mg*.
- A commercial chicken vaccine does not protect day-old pheasant chicks from *Mg* infection.

Chris Davis

Administering a vaccine to pheasants on our rearing field at Fordingbridge. (Sophia Miles)

This work is part-funded by the National Gamekeepers' Organisation and carried out at Liverpool University Veterinary School by Mrs Anne Forester and Dr Janet M Bradbury.

Mycoplasma gallisepticum (*Mg*), a pathogen of chickens and turkeys, has been a suspected cause of upper respiratory disease in gamebirds. Its role as the primary pathogen was confirmed experimentally in chukar partridges in the USA and in red-legged partridges in the UK, but it has never been proved that *Mg* is a primary pathogen in pheasants. We therefore conducted a series of trials designed to understand *Mg* in pheasants.

An accurate test for *Mg*

We compared different tests for diagnosing *Mg* in pheasants using paired blood samples and respiratory tract swabs. We found that the most commonly used 'Rapid Serum Agglutimation' (RSA) test was not as accurate as the 'Polymerase Chain Reaction' (PCR) test. Our results show that it is possible for a pheasant to be carrying *Mg* without a positive RSA test. The PCR test is therefore the method of choice for rapid and accurate diagnosis (see Table 1). There was little evidence of *Mycoplasma synoviae*, another pathogen associated with current *Mycoplasma* outbreaks in chickens, throughout this study.

Table 1

Number of pheasants positive for *Mg* diagnosed by three methods

	Number (and %) positive		
Number of pheasants	***Culture***	***RSA***	***PCR***
633	25 (4%)	100 (16%)	139 (22%)

Corvids as a possible source of *Mg*

Some previous work had suggested that corvids might carry *Mg*. Therefore, using the PCR test, we tested samples from 232 crows, 128 rooks, 41 jackdaws, 47 magpies and four jays. We found *Mg* infection in only six (four crows, a rook and a magpie), indicating a very low prevalence. It appears that corvids are not common hosts for *Mg*. This suggests that at present corvids are not the main source of *Mycoplasma* infection in pheasants.

***Mg* as the cause of respiratory disease in pheasants**

We infected groups of one-day-old pheasant chicks with five different *Mg* isolates from pheasants, infected a further group with a turkey *Mg* strain (*Mg*/S6), and 'sham-vaccinated' a control group with sterile *Mycoplasma* broth.

Birds in all the infected groups developed typical signs of respiratory disease (sinusitis, conjunctivitis and nasal exudation). This caused clinical signs of infection in 54-100% of cases. *Mg* was re-isolated from almost all the infected birds, but not from any of the control group. Birds from the infected groups tested positive for *Mg* at the end of the trial (see Table 2).

This experiment strongly suggests that *Mg* is a primary pathogen in pheasants and that these recent UK isolates are pathogenic.

***Mg* vaccine trial**

We tested a vaccine for *Mg*, recently licensed in the UK for use in chickens, for its efficacy and safety in pheasants for which there were no data available.

We vaccinated six groups of 12 one-day-old pheasant chicks by aerosol and the same number with sterile distilled water (sham-vaccinated). We then challenged all the birds at 10 days old with a field strain of *Mg* (isolate G87/02). As a control we left two further groups (each of 12 birds) unchallenged - one vaccinated and the other sham-vaccinated.

We observed clinical signs of *Mg* infection (conjunctivitis, sinusitis and nasal

Table 2

Pathogenicity trial: % showing clinical signs of infection, RSA test and number of birds with re-isolation of *Mg*

Group	***% showing clinical signs****	***No of birds* Mg-*positive by RSA***	***No of birds* Mg-*positive by isolation***
Controls	0	0/6	0/12
Turkey *Mg* (*Mg*/S6)	66	6/6	11/12
Pheasant *Mg* (G9/01)	54	6/6	11/13
Pheasant *Mg* (G42/02)	100	5/5	13/13
Pheasant *Mg* (G87/02)	77	7/7	13/13
Pheasant *Mg* (G102/02)	85	7/7	13/13
Pheasant *Mg* (G118/02)	85	7/7	13/13

* *rounded to nearest whole figure*

Table 3

Vaccine trial: % showing clinical signs of infection, RSA test and number of birds with re-isolation of *Mg*

Group	***% showing clinical signs***	***No of birds* Mg-*positive by RSA***	***No of birds* Mg-*positive by isolation***
Sham-vaccinated/unchallenged	0	0/10	0/10
Vaccinated/unchallenged	0	0/10	0/10
Sham-vaccinated/challenged	93	23/24	52/59
Vaccinated/challenged	95	23/24	49/59

* *rounded to nearest whole figure*

exudation) in all groups that were challenged with *Mg* including those that were vaccinated (see Table 3), but there were no clinical signs of infection in the controls.

The results of this trial indicate that, although the vaccine appeared to be safe for young pheasants, it failed to protect them. This may be because the birds were immunologically immature. Clearly one day old is not a suitable time for using this vaccine. More work is being planned.

High pressure aerosol allows droplets of the vaccine to reach the birds' lungs when inhaled. (Sophia Miles)

Predation research summary for 2003

Key achievements

- Development and testing of 'best practice' for mink control in the context of wildlife conservation, followed up by an education programme including literature and workshops.

Jonathan Reynolds

In 2003, the success of our studies on mink control dominated predation research at the Trust. In wildlife conservation, as much as in game conservation, predator control must fulfil a number of criteria to be defensible. It must have a rational basis - a known mechanism by which it leads to the desired goals, and a high probability of reaching them. It must therefore be affordable. It must be proportionate to its aims, and as target-specific and humane as possible.

As is common with predator control, there is often confusion about what aim is appropriate (eradication, temporary control, or indefinite control?), and there is widespread doubt that any useful aim is realisable using existing methods. In some quarters there is uncertainty over what is involved, and some wildlife groups have embarked on mink-culling programmes without having thought through the issues.

In the two years of our involvement, we have developed a method - the GCT Mink Raft - that allows effective control of mink numbers, and answered or clarified many fundamental questions about aims, costs, strategies and evaluation. We have disseminated 'how-to' information widely through the conservation world (eg. a workshop at Fordingbridge was attended by members of 35 conservation bodies), while stressing a philosophy of appropriate and responsible action. There has been considerable favourable media coverage resulting.

The subject of mink control is one where conservation priorities argue strongly in favour of predator control, despite the distaste that many wildlife conservationists have for killing. It reflects well on game conservation that, not only can we give practical advice on predator control, but we can show how to carry it out responsibly. But there is no room for complacency. Few predator control issues are as straightforward as mink and, for long-established practices, comparable advances will be much harder to attain.

Mink were the chief focus of our predation control work in 2003. (David Mason)

Predation research in 2003

Project title	Description	Staff	Funding source	Date
Mink control strategies (see page 86)	*Experimental eradication of mink on parts of Itchen and Avon catchment*	*Jonathan Reynolds, Mike Short*	*Environment Agency/ Core funds*	*2003*
Fox control methods	*Experimental field comparison of fox capture devices*	*Jonathan Reynolds, Mike Short*	*Core funds*	*2002-2004*
Mammal population trends (see page 92)	*Extracting cull data on mammalian game species and predators from the NGC*	*Jonathan Reynolds, Nicholas Aebischer, Claude Gillie*	*JNCC*	*2003-2008*

Sophisticated mink trapping

In 2002 we invented and trialed the GCT Mink Raft, a low-technology device intended to underpin a new approach to mink control (see our *Review of 2002* pages 42-46). The raft proved a sensitive way to detect mink, and therefore promised substantial benefits by directing trapping effort solely at locations *with* mink, rather than wasting time on locations *without* them.

The next step, clearly, was to use our raft to guide a trapping campaign. Thanks to support from the Environment Agency, we were able to do this on two different rivers in 2003. We tackled these sequentially, so that lessons learnt on one could be applied to the other.

On the lower River Itchen in Hampshire (between Winchester and Eastleigh), field surveys by the Hampshire Wildlife Trust had shown a 13% decrease between 1996 and 2002 in the number of sample sites with water voles present. This was accompanied by an increase in mink signs from 'absent throughout' in 1996 to 'present throughout' in 2000. Conservation bodies in the area decided that urgent action was needed to safeguard the water voles.

We aimed to eliminate mink from this 12-kilometre section of river for the period April to July, and hoped to demonstrate that by trapping we had removed all detectable mink. Although the raft as the basis of a trapping strategy was on trial, in large measure we were also seeking to develop the best strategy for its use. So we deliberately 'over-gunned' our approach on the Itchen, knowing that from a successful outcome we could define more efficient operating rules for the future.

In total, we deployed 104 rafts in late March/April. This high density (about 10 rafts per kilometre of river corridor) ensured that around six rafts would be available to any female mink, which typically occupy a breeding territory about 1.5 kilometres long. Although pilot work had suggested that raft positioning was not critical, we wanted to leave no doubt that a mink would find at least one raft. Rafts can operate in two modes: as monitors to detect the presence of mink, and as trap sites. In this study, rafts in monitoring mode were checked for footprints at weekly intervals. Once

Key findings

- Using the GCT Mink Raft to direct trapping, we were able to achieve a substantial impact on mink in a short time and on a scale of up to 45 kilometres of river.
- During the same period, water vole evidence spread dramatically along the river from nucleus populations.

Jonathan Reynolds

Water voles made a comeback as we depleted mink numbers. (David Mason)

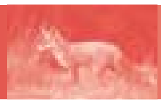
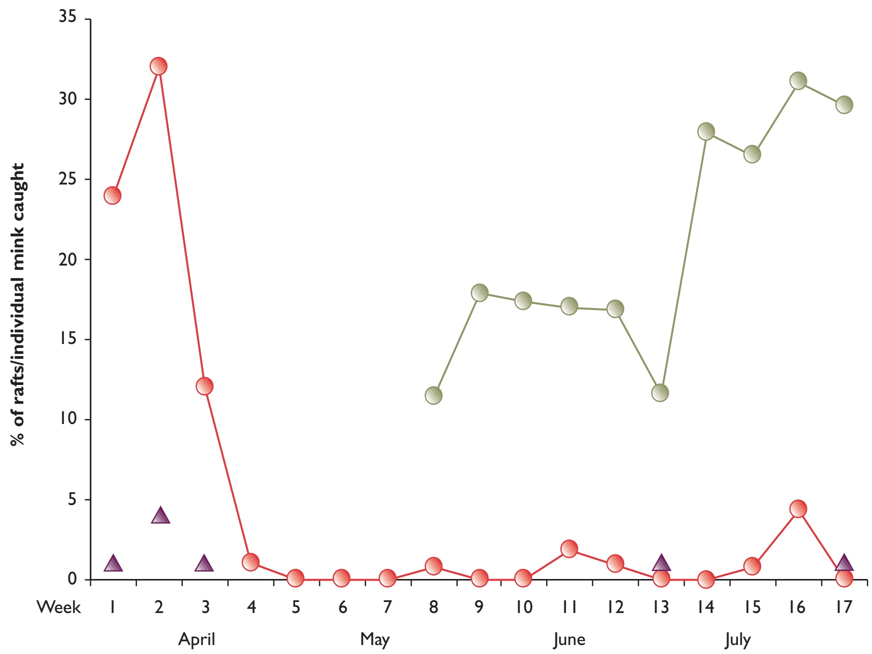


Figure 1

Proportion of rafts showing evidence of mink and water voles for 17 weeks during the spring and summer on the River Itchen



we detected mink on a raft, a cage trap was set within the raft tunnel and we checked it daily until it caught a mink, or for up to four weeks. All of these arrangements were deliberately fail-safe choices. Rafts reverted to monitoring mode after each trapping session.

In conventional trapping, a proportion of trap sites will be redundant because there are no mink active there. For instance, on the upper Avon and its tributaries in 2002, with raft sites placed at a much lower density of one per four square kilometres (400 hectares), 70% showed no mink activity throughout the summer. A second form of redundancy arises where a mink has access to several traps, because it can get caught in only one of them. So after a capture, the dilemma is whether to close down nearby traps, or to keep them running. The dilemma is heightened through not knowing which traps were accessible to the mink already caught, nor whether other mink have access to the same traps. Using rafts, this is resolved by reverting to monitoring mode. If another mink is present it will leave tracks and can be trapped in turn. Thus, mink signs on rafts become both the guiding hand and proof of effectiveness for the trapping campaign.

On the Itchen, the proportion of rafts showing mink signs quickly collapsed to near-zero on the removal of just a few mink (see Figure 1). In fact, the catch at this point was so low that we seriously wondered whether we were missing any. Accordingly, we shifted all rafts on the main river channel to fresh, intermediate positions. Further 'blips' of mink activity were met with the removal of three more mink. Including two mink killed shortly before we started, a total of seven females and three males were killed on the river. A hypothetical breeding territory drawn around each female capture convincingly explains most of the raft evidence and neatly fills up the river corridor, suggesting that we probably did account for most or all breeding females.

During the same period, water vole evidence (also, fortuitously, recorded on rafts) spread dramatically (see Figure 1). Geographically, water voles spread from isolated nucleus colonies in mid-May, to occupy almost the entire river channel by late July (see Figure 2 overleaf). An impressive capacity for population growth and spread to take advantage of temporary summer habitats is characteristic of water voles, but sadly it hasn't been evident in recent decades. Its occurrence here encourages our belief that we had a substantial impact on mink numbers. Certainly we prevented the birth of 49 young mink: culled females carried from five to 10 embryos (see Figure 3 overleaf).

Importantly, the mink captures were accompanied by only 10 live captures of non-target species (six water voles, grey squirrel, brown rat, moorhen, mallard). Several of these were re-captures. All but one occurred in traps rendered redundant by nearby mink captures, and could therefore have been avoided by reduced trap deployment times. In conservation terms, the occasional detainment of these animals in live-catch traps is trivial compared with the benefits of controlling mink.

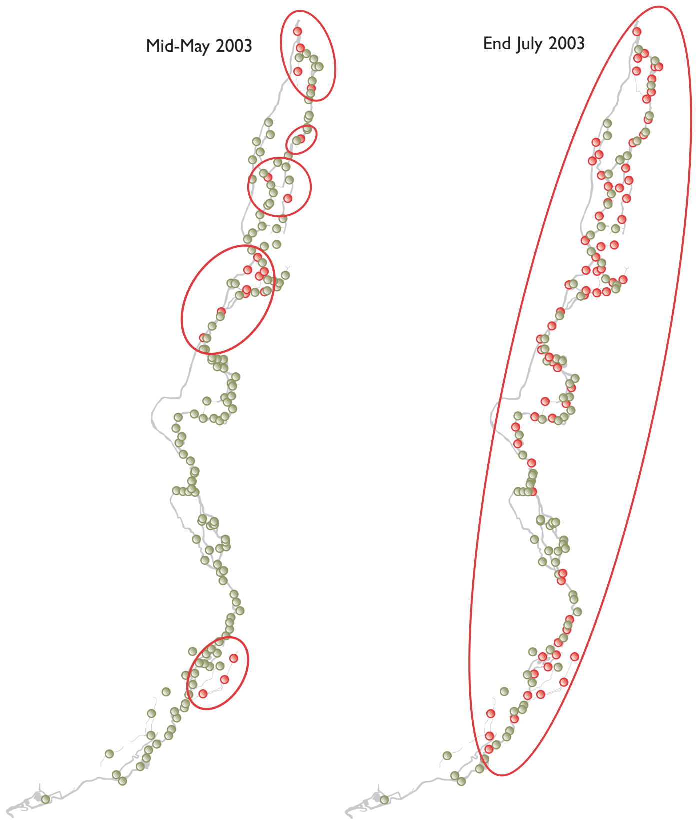


Figure 2

The spread of water voles on the River Itchen from mid-May to the end of July

- Rafts with evidence of water voles
- Rafts with no evidence of water voles

The Itchen experience allowed us to refine our raft- and trap-operating rules for the next stage. This time, we repeated the exercise on a larger scale beginning in autumn. The River Wylye, one of the Avon tributaries, is 45 kilometres long and, in summer 2002, we had found mink throughout its length. Autumn implied greater challenges than spring because mink numbers are at their annual peak in autumn following breeding, and because dispersal could mean that a mink leaving tracks on a raft could have moved elsewhere before a trap was set.

Our refined operating strategy for the Wylye was to use one raft per kilometre of river, to check at two-week intervals during the monitoring phase and to run traps for a maximum of 10 days each before reverting to monitoring mode. The distribution of mink was somewhat changed from that found in 2002, with no tracks at 40% of raft

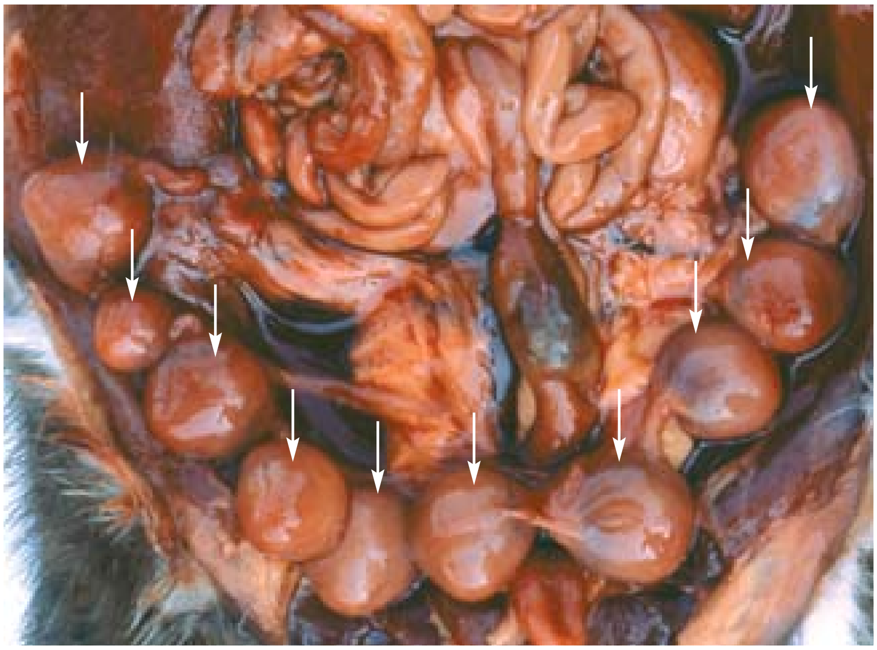


Figure 3

Mink breed only once a year, but can be very productive. This female carried 10 foetuses (each denoted by an arrow). The smallest pregnancy we found was five foetuses.

Mike Short and Tom Porteus with one of the GCT Mink Rafts. (Jonathan Reynolds)

sites. We caught a total of seven mink (six females and one male) and - just as on the Itchen - mink evidence on rafts declined rapidly in response (see Figure 4).

The Itchen and Wylye projects have shown that, using rafts to direct trapping effort, a substantial impact on mink numbers was possible in a short time, irrespective of time of year. As far as we could tell, we eradicated mink from the target areas for the duration of each project, though given that trap-shyness arises in so many pest control issues, it would be incautious to assume this. Other anticipated benefits of the raft system have been borne out in practice: substantially reduced non-target captures (and hence improved animal welfare), good cost-efficiency, and the ability to monitor water vole presence.

Although demonstrably effective trapping on this kind of geographical scale is unprecedented, we anticipate that recolonisation will be quite rapid. Thus the challenges are no longer so much 'how to do it', but logistic problems of how to manage a progressive control programme that gradually creates a wider and longer-lasting mink-free zone, and how to fund the inescapable cost.

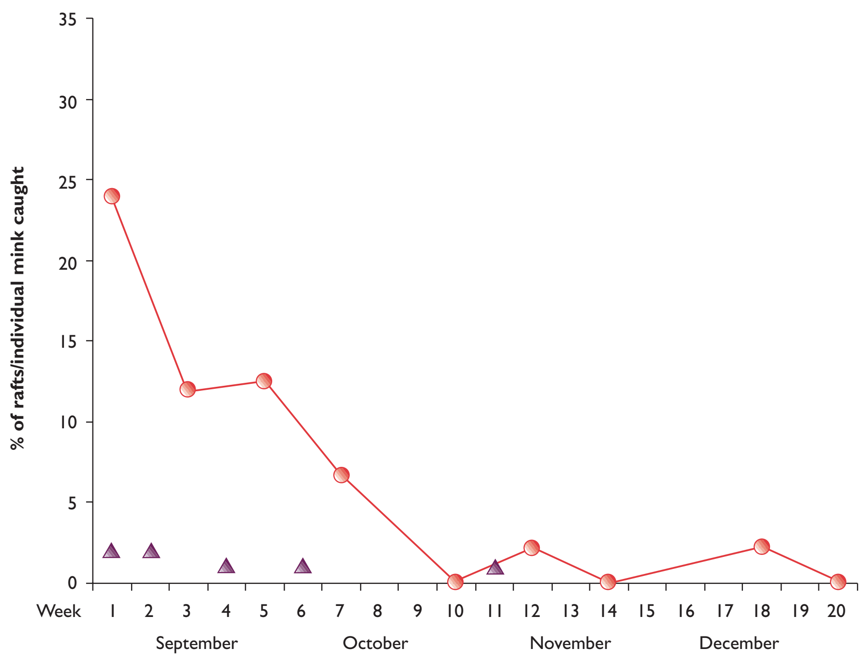
These research projects were jointly funded by The Game Conservancy Trust, the Environment Agency and Hampshire Wildlife Trust.

Figure 4

Proportion of rafts showing evidence of mink for 20 weeks during the autumn and winter on the River Wylye

Mink evidence

Mink captures



Reading the lines - foretelling the mink cull

Skilled trackers in hunting cultures, as every schoolchild knows, can not only distinguish between individual big game animals by their footprints, but also assess the condition of the animal. To do this, they make use of any unique characters (eg. injuries or deformities), but often have to recognise a subtle combination of shape, size and other features, while mentally filtering out the effects of weather and substrate condition on the track itself. Wildlife biologists obliged to work on species without decades of apprenticeship in the field have occasionally tried to achieve the same prowess by detailed measurement of tracks, followed by statistical analysis.

Although mink tracks are small compared with lion tracks, those gathered on mink rafts are superbly detailed. It would be extremely valuable to know from initial raft checks how many mink were available to trap at a series of rafts, or at least which were males and which females. Natalie Fisher, an MSc student from Bangor University, undertook to try this for us.

We took two approaches. First, captured mink were made to run across a track pan. Numerous measurements were taken from digital images of the tracks, and the combinations of these that best distinguished between the tracks of different individuals were derived by statistical analysis. Second, all mink tracks made at rafts before trapping were passed through computer software designed to spot natural groupings and to classify data accordingly. This is described as 'unsupervised learning' because no examples or prior knowledge are used to guide classification: the software doesn't need to know how many groupings there are or what they look like.

Although the tracks of known individuals differed in an identifiable way, there was considerable overlap, so tracks could be ascribed to a particular individual with only low confidence. Even though male mink are generally much larger than females, there was sufficient overlap in foot size and shape that no track could confidently be ascribed to either sex. The unsupervised learning software threw up a number of groupings that matched the number of individuals caught, but on close inspection this turned out to be coincidence. Both approaches may improve as we acquire more material for analysis, but the whole process was extremely laborious. At best, it may prove a useful research tool, but it clearly isn't suited to general use in mink trapping practice.

Key findings

- Mink tracks recorded on the GCT Mink Raft are perfectly detailed, suggesting the possibility of discerning males from females, or even individuals.
- Sadly, we were unable to do this with any reliability.

Jonathan Reynolds

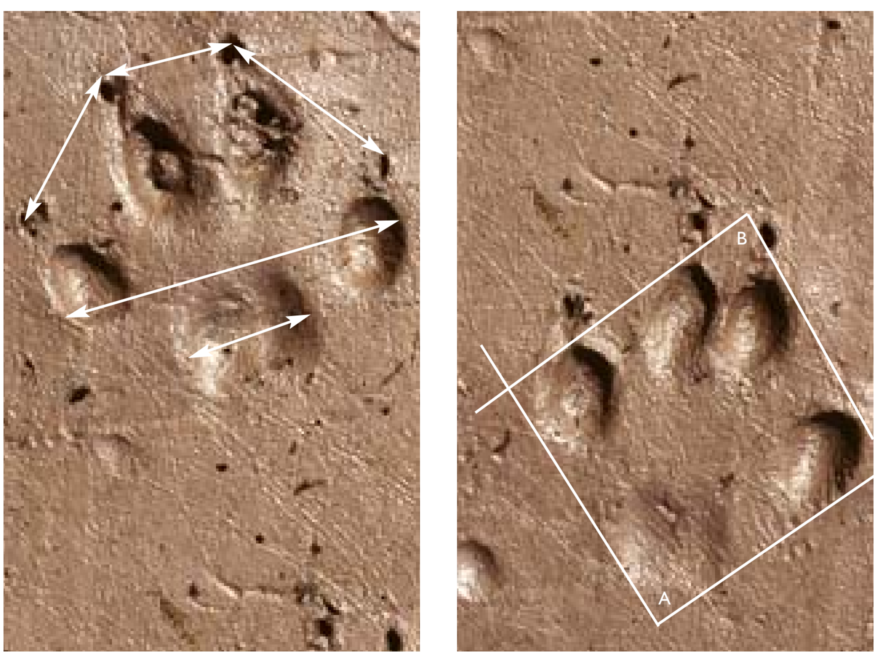


Figure 1

Mink tracks are small, but when they are this clear measurements are easy to take. Potentially they might allow us to estimate the number of mink present before trapping.

Recent trends in predator culls

Key findings

- Numbers of culled foxes, mink and magpies have increased, while those of weasel have declined over the period 1961-2003. Culls reflect effort as well as abundance.

Nicholas Aebischer

Through the National Gamebag Census (NGC), we monitor not only game but also the numbers of predators killed by gamekeepers and farmers as part of their predation control. These records provide an indication of long-term changes in abundance for a range of species that, in some cases, are poorly covered by other national monitoring schemes. We review here the trends for six common predators: red fox, stoat, weasel, American mink, carrion/hooded crow and magpie.

All six of these species can be controlled throughout the year, and their legal status has not changed since the NGC began in 1961. We collect records by mailing questionnaires to contributors at the end of each season. These total around 500 shoots and estates in England, Scotland, Wales and Northern Ireland. Participation in the NGC is voluntary, and we are grateful to all owners and keepers who send in returns each year. For each of the species, we present summaries of the national trends from 1961 to 2002 based on the average annual number of animals killed per 100 hectares.

Figure 1

Numbers of red foxes killed per km² (100 hectares) of total estate area annually in the UK from 1961 to 2002. Error bars represent 95% confidence intervals.

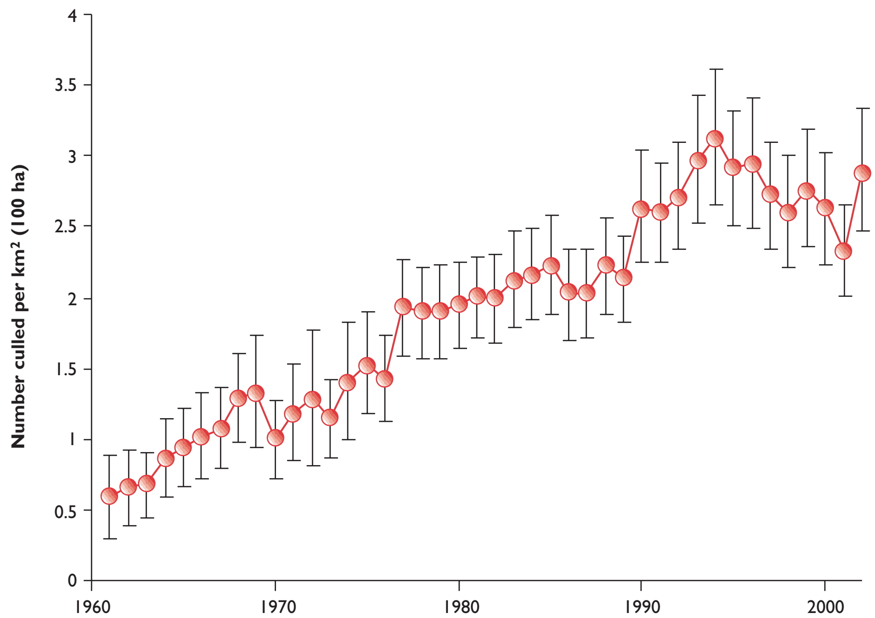
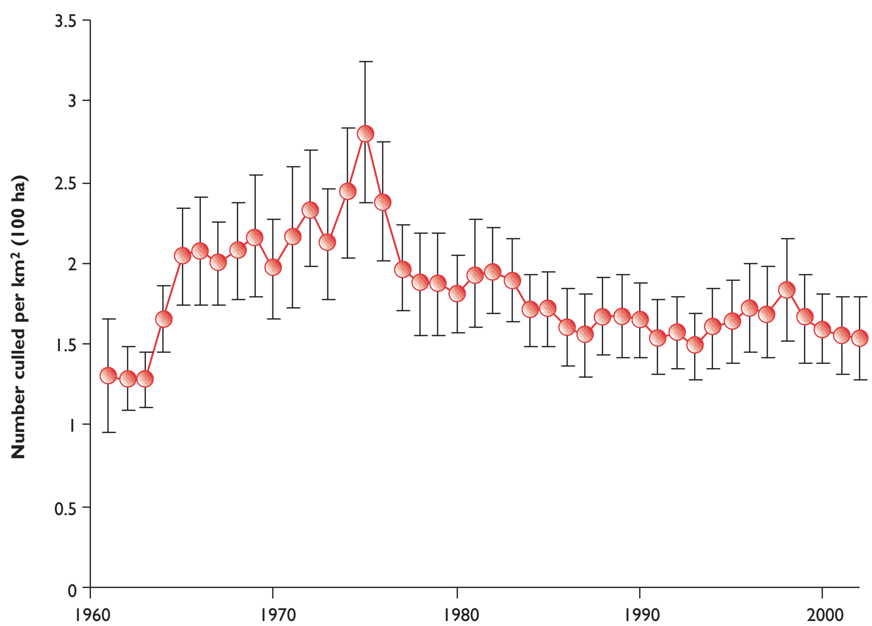


Figure 2

Numbers of stoats killed per km² (100 hectares) of total estate area annually in the UK from 1961 to 2002. Error bars represent 95% confidence intervals.



Numbers of foxes culled have risen probably as a result of increased abundance linked to greater food availability. (David Mason)

Red fox (Figure 1)
Since the early 1960s, the average cull has increased five-fold. The increase was steady until the early 1990s, after which it may have levelled off or even declined. Fox density may have been depressed following myxomatosis in rabbits in the 1950s, and part of the increase may reflect the subsequent rabbit recovery. Changes in fox control methods, particularly the use of spotlights, have undoubtedly affected the size of the cull and the large-scale rearing and releasing of gamebirds has probably improved their food supply.

Stoat (Figure 2)
The stoat is a gamebird predator whose abundance is closely linked to rabbit numbers. Until the mid-1970s, the increase in cull is similar to that of the fox, probably reflecting the rabbit recovery from myxomatosis. Since then, the number killed has dropped to a level close to that in the 1960s. This is consistent with a decline in trapping effort arising from a greater emphasis on reared gamebirds.

Trapping effort is likely to have dropped for the stoat, an important predator of nests and chicks, as more emphasis has been placed on reared gamebirds. (David Mason)

Weasel (Figure 3)
The numbers of weasels trapped shows an on-going decline through 40 years, with numbers now being only a quarter of those in the early 1960s. Weasels feed mainly on field voles, whose prime habitat is rough grassland. It seems likely that the trend is

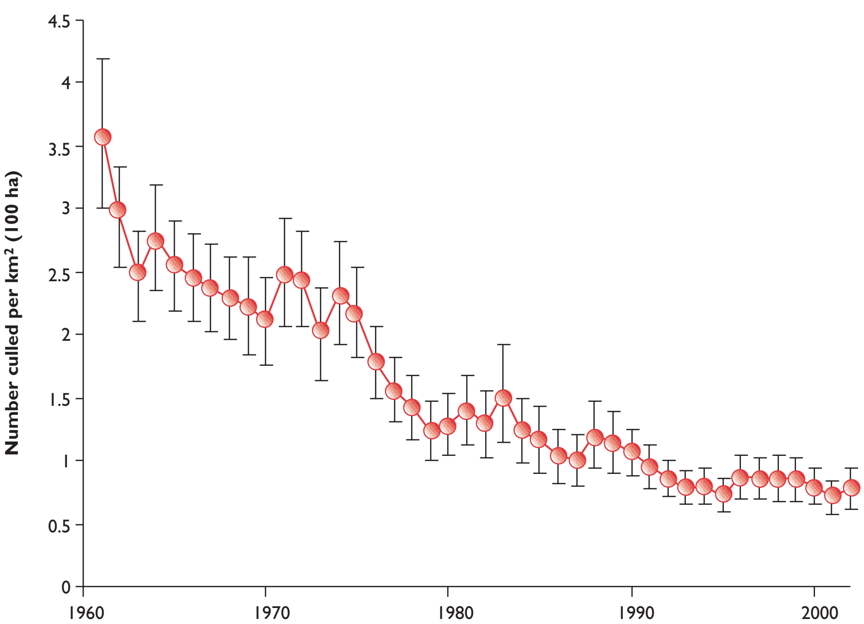
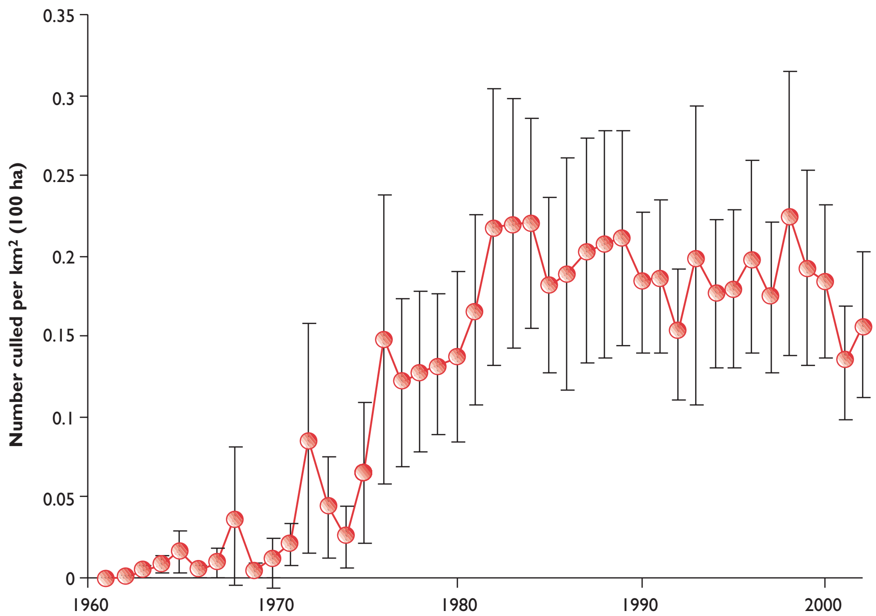


Figure 3

Numbers of weasels killed per km^2 (100 hectares) of total estate area annually in the UK from 1961 to 2002. Error bars represent 95% confidence intervals.

Figure 4

Numbers of American mink killed per km² (100 hectares) of total estate area annually in the UK from 1961 to 2002. Error bars represent 95% confidence intervals.



a combination of two factors. Firstly, a decline in the number of voles caused by habitat loss as rabbits recovered from myxomatosis. Secondly, a decline in trapping effort from the mid-1970s, linked to increased hand-rearing of gamebirds.

American mink (Figure 4)

The first record of mink breeding in Britain was in 1956, and the cull illustrates a rise from near zero. After 15 years of relative stability, there is a hint that the cull has declined recently. This may be connected to an increase in otter numbers. The mink is considered responsible for the disappearance of water voles from many parts of the country, and it is possible that efforts to step up mink control by conservationists are having some impact on numbers available for trapping on shooting estates.

Numbers of crows killed have changed little through time, even though the UK crow population has doubled. (David Mason)

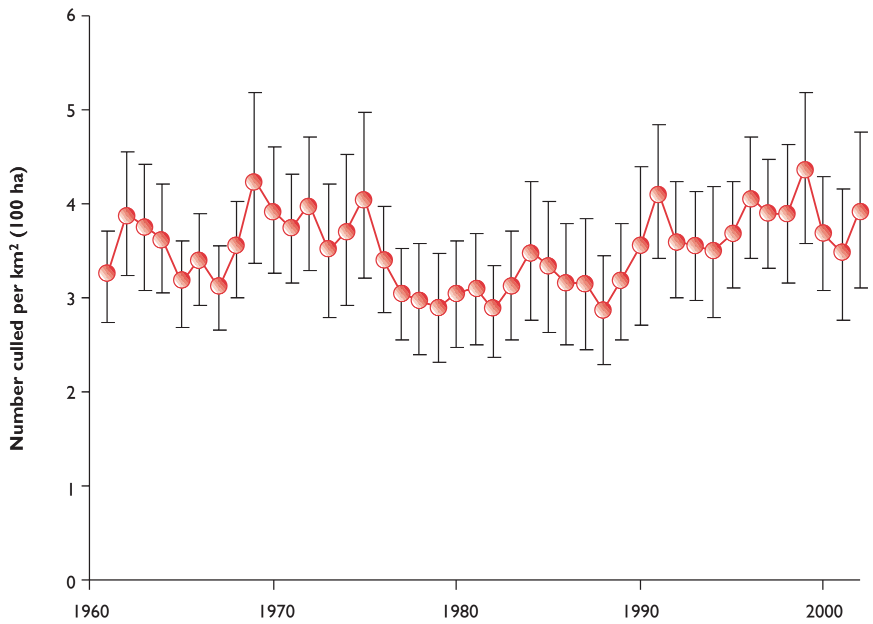


Figure 5

Numbers of carrion crows killed per km^2 (100 hectares) of total estate area annually in the UK from 1961 to 2002. Error bars represent 95% confidence intervals.

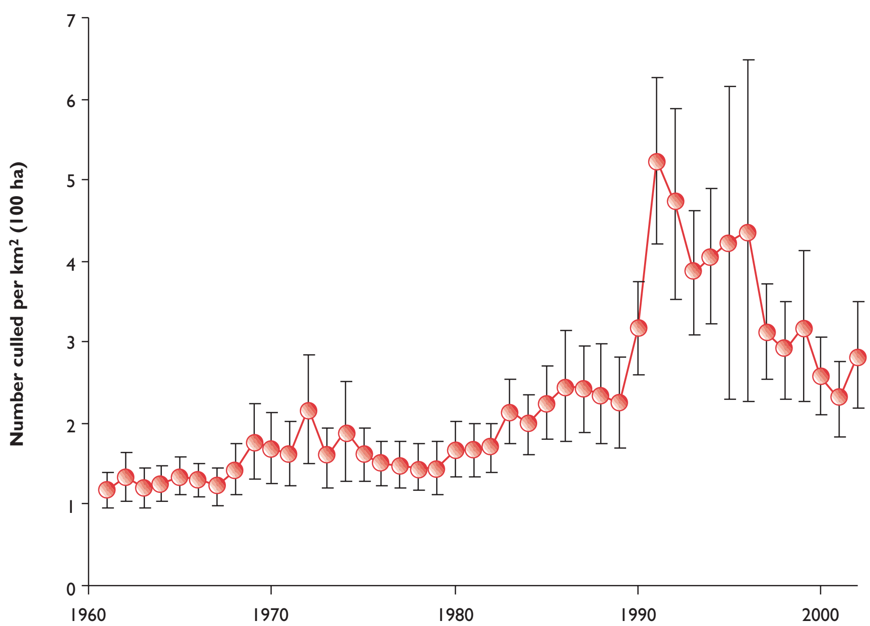


Figure 6

Numbers of magpies killed per km^2 (100 hectares) of total estate area annually in the UK from 1961 to 2002. Error bars represent 95% confidence intervals.

Carrion crow (Figure 5)
Records of this species include the hooded crow from the Scottish Highlands, which like the carrion crow is a predator of gamebird eggs. The average number of crows killed has changed little through time. There was a slight increase during the 1990s compared with the 1980s, which may be due to the introduction of the Larsen trap. However, the change is considerably less than the population trend from the British Trust for Ornithology's Common Birds Census (CBC), which shows a two-fold increase between 1968 and 1999. It is possible that the effectiveness of crow control is purely at a local scale, so that numbers have remained approximately constant on shooting estates while increasing on unkeepered farmland.

Magpie (Figure 6)
The magpie is a common predator of gamebird and songbird nests, whose abundance has doubled between 1966 and 1990 according to the CBC. The cull reflects this increase. Since 1990, a large increase in numbers killed reflects the widespread adoption of the Larsen trap for magpie control on shooting estates. The number peaked in 1991 and has declined since, probably because the Larsen trap has reduced magpie densities locally. The Larsen trap may also have influenced national densities as the CBC trend in magpie density has also levelled off since 1990.

Join the census

The Trust is continually seeking new participants to expand the coverage and accuracy of the NGC, so we encourage all readers who do not already contribute to contact the National Gamebag Census Co-ordinator in Fordingbridge. Please call 01425 652381 for more information.

River ecology summary for 2003

Key achievements

- During 2003 we completed 24 kilometres of bank-side coppicing and fencing on the River Monnow tributaries.
- We collected data from 120 sites across six different rivers for our trout stocking study.
- We continued to produce practical information for other fishery managers to use.

Ian Lindsay

Compared with just a decade ago, fishery management research now provides a wide range of management prescriptions and habitat improvement techniques for river or fishery owners. In addition, just as other areas of Trust work have been adopted by a number of agri-environment schemes, river-bank fencing, bank-side coppicing and a range of other prescriptions investigated by the Trust in the 1980s and 1990s are now widely adopted within Countryside Stewardship and similar conservation grant schemes in Wales and Scotland.

The main focus of recent fisheries research has been to extend and test the application of existing techniques across a wider range of river types and, in particular, to investigate the impact of fisheries management techniques on a range of important (and often designated) wildlife species. Many of the results are central to work on the River Monnow, led by the Trust, which over the next three years will undertake approximately 60 kilometres of river bank habitat improvement in what is the biggest catchment-based, wild trout restoration project carried out in the UK. To date, only limited science is available to quantify the impact of these techniques on fish and other wildlife species, so to address this the Monnow Project is underwritten by an important scientific monitoring programme. As many trout rivers become subject to increasing conservation designations it seems likely that the continuation of traditional fishery management on these rivers will be increasingly dependent on measured benefits to other species of conservation concern.

Building on many years of trout research investigating issues such as predator removal and habitat improvement, in 2001 the Trust embarked on a major research

Ian Lindsay beside a stretch of the River Monnow that was fenced in 2003. (Sophia Miles)

Our stocking project requires painstaking collection of data for wild and reared trout. (Louise Shervington)

Below: Clearing up after coppicing on the River Monnow is a mammoth task. (Sophia Miles)

project across six rivers to investigate the impact of stocking on wild trout stocks. This work is directly relevant to major concerns, highlighted by the Environment Agency's Trout and Grayling Strategy, relating to current trout stocking practice and the possible impacts of artificial stocking on wild trout stocks. During 2003, the work included experimental stocking of over 120 sites for which baseline population data had been gathered in 2002. After further stocking of these sites in 2004, this project should provide essential information for better guidance of future policy and identify for a given river type the optimal stocking management consistent with the conservation of wild trout stocks.

Fisheries research in 2003

Project title	Description	Staff	Funding source	Date
Fisheries research	*Developing wild trout fishery management methods*	*I Lindsay, D Roberts, D Stubbing*	*Core funds, GC London Fish Group, Reseach Funding Appeal*	*1997-2003*
Habitat improvement	*Monitoring brown trout and juvenile salmon after fencing and coppicing*	*Ian Lindsay, Dylan Roberts*	*Environment Agency Wales*	*1998-2004*
PhD: Trout stocking	*Investigating the impact of stocking on wild trout stocks to identify optimal stocking strategies*	*R Chatterji (Supervisors: Prof Peter Williams and Dr Tony Bark, Kings College, London) and I Lindsay, D Roberts, D Stubbing*	*Wild Trout Trust, British Trout Farmers Restocking Assoc, GC London, Regional Fisheries Clubs*	*2002-2005*
River Monnow project (see page 98)	*Large-scale conservation and scientific monitoring of 57km of river habitat*	*Ian Lindsay, Dylan Roberts*	*Defra Rural Enterprise Scheme*	*2003-2006*

Trout monitoring on the River Monnow

Key findings

- 2003 saw the first data collected on the River Monnow, giving us a baseline for future years.
- Juvenile brown trout numbers were moderate.
- Adult brown trout numbers were poor.
- There is room for improvement.
- Baseline results are broadly comparable with the first year's data from our fisheries monitoring of the River Wye habitat improvement project.

Dylan Roberts

The upper River Monnow catchment suffers from widespread stock access and over-shading. This causes the suppression and destruction of marginal vegetation, which is important as an erosion buffer during winter spates and acts as a form of cover for trout, other fish and aquatic invertebrates. The aim of the project is therefore to restrict stock access by fencing and increase illumination by coppicing.

One of the main reasons for monitoring fish in the River Monnow project is to measure and compare the impact of fencing and coppicing on brown trout on high- and low-gradient rain-fed rivers. This work is important in telling us what type of rivers respond best to the fencing and coppicing treatment, so that we can direct funding more effectively. This comparison is possible because the upper Monnow catchment, the target area for the project, consists of four main tributaries. Three of these, the Olchon, upper Monnow and Escley, are typical high-gradient streams, with fast riffles flowing over a boulder and cobble substrate. The fourth, the Dore, is a low-gradient stream with a typical meandering pool/riffle sequence over a gravel substrate.

Our project has many similarities to our research on the Clywedog Brook, which also suffered from over-grazing and over-shading problems. However, the Clywedog flowed over a 'moderate' gradient, which is not typical of all river types. One of the unfortunate aspects of such research is that monitoring must continue over a number of years to be able to measure fully the impact of habitat management techniques. We are hoping, if funding permits, to go back to our experiment on the Clywedog to measure the impact of the fencing and coppicing that was undertaken in 1998 and 1999 as part of the Wye Habitat Improvement Project.

In 2003 on the Monnow we put in place our experimental design, which consists of 10 pairs of adjacent randomly-selected 500-metre control and management stretches on the four streams. During the summer we undertook a baseline electro-fishing survey to measure densities of fish before fencing and coppicing began. During the 2003/2004 winter, the management sites will be fenced and coppiced and our electro-fishing survey will be repeated in the summer of 2004.

Above: Electrofishing on the River Monnow provided baseline surveys of trout and other species. (Dylan Roberts)

Right: We also gathered data on species with important European conservation status, such as white-clawed crayfish. (Dylan Roberts)

The River Olchon, a tributary of the River Monnow, was one of the sites where we gathered data in 2003. (Dylan Roberts)

As well as counting and measuring brown trout in the baseline survey, we also gathered data on bullheads, brook lampreys and, in conjunction with Cardiff University, white-clawed crayfish (see Figure 1). Each of these species has an important European conservation status (each is a Biodiversity Action Plan species and is listed in Annex 2 of the EU Habitats Directive). Other fish species caught and recorded included grayling, eel, stone loach and minnow.

Early indications from the results of the baseline monitoring suggest that numbers of juvenile brown trout are moderate, but numbers of older trout are generally poor and these data are similar to those recorded on the Clywedog in 1998.

Therefore, there is plenty of room for improvement and, hopefully, when the habitat measures start to take effect over the next few years, the Monnow will once again be regarded as one of the premier wild brown trout fisheries in the country.

The River Monnow Project is a partnership of 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.

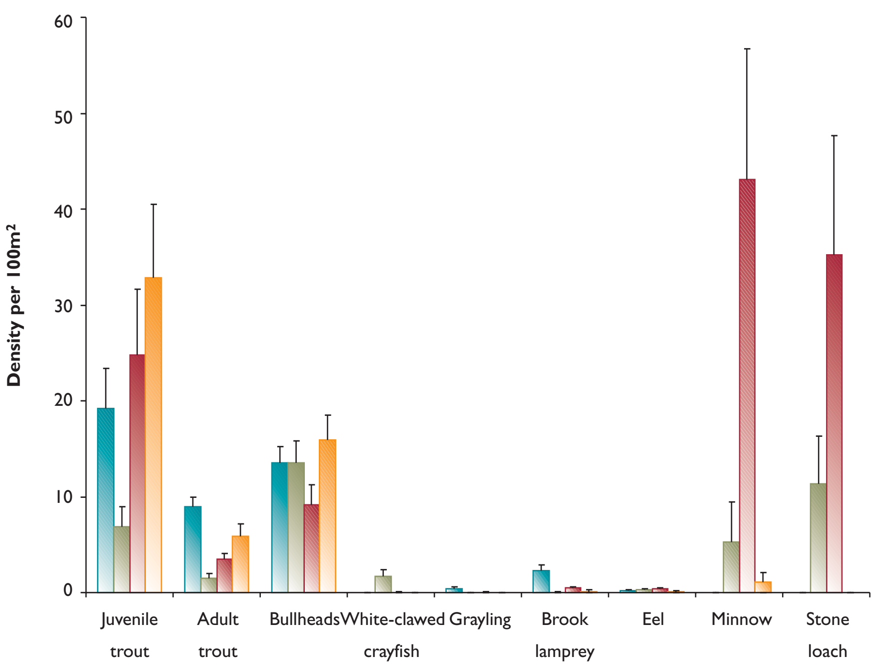


Figure 1

Baseline survey of the species in four tributaries of the River Monnow

Scientific publications in 2003

by staff of The Game Conservancy Trust

Aebischer, NJ, Baker, SE, Johnson, PJ, Macdonald, DW & Reynolds, JC (2003)
Hunting and fox numbers in the United Kingdom.
Nature, 423: 400.

Amar, A, Redpath, SM & Thirgood, SJ (2003)
Evidence for food limitation in a declining raptor population.
Biological Conservation, 111: 377-384.

Baines, D & Andrew, M (2003)
Marking of deer fences to reduce frequency of collisions by woodland grouse. *Biological Conservation*, 110: 169-176.

Bence, SL, Stander, K & Griffiths, M (2003)
Habitat characteristics of harvest mouse nests on arable farmland. *Agriculture Ecosystems & Environment*, 99: 179-186.

Brickle, NW & Harper, DGC (2002)
Agricultural intensification and the timing of breeding of corn buntings *Miliaria calandra*. *Bird Study*, 49: 219-228.

Browne, SJ & Aebischer, NJ (2002)
Temporal changes in the breeding and feeding ecology of turtle doves (*Streptopelia turtur*) in the UK: an overview. In: *Proceedings of the XXVth International Congress of the International Union of Game Biologists and the IXth International Symposium Perdix*.
Ed: E Hadjisterkotis. *European Journal of Wildlife Research,* 48 Supplement: 215-221.

Browne, SJ & Aebischer, NJ (2003)
Habitat use, foraging ecology and diet of turtle doves *Streptopelia turtur* in Britain. *Ibis*, 145: 572-582.

Browne, SJ & Aebischer, NJ (2003)
Temporal changes in the migration phenology of turtle doves *Streptopelia turtur* in Britain, based on sightings from coastal bird observatories. *Journal of Avian Biology*, 34: 65-71.

Browne, SJ & Aebischer, NJ (2003)
Temporal variation in the biometrics of turtle doves *Streptopelia turtur* caught in Britain between 1956 and 2000.
Ringing & Migration, 21: 203-208.

Browne, SJ & Mead, CJ (2003)
Age and sex composition, biometrics, site fidelity and origin of bramblings *Fringilla montifringilla* wintering in Norfolk, England.
Ringing & Migration, 21: 145-153.

Cattadori, IM, Haydon, D, Thirgood, SJ & Hudson, PJ (2003)
Are indirect measures of abundance a useful index of population density? The case of red grouse harvesting data.
Oikos, 100: 439-446.

Collins, KL, Boatman, ND, Wilcox, A & Holland, JM (2003)
A five-year comparison of overwintering polyphagous predator densities within a beetle bank and two conventional hedge-banks. *Annals of Applied Biology*, 143: 63-71.

Collins, KL, Boatman, ND, Wilcox, AW & Holland, JM (2003)
Effects of different grass treatments used to create over-wintering habitat for predatory arthropods on arable farmland.
Agriculture, Ecosystems and Environment, 96: 59-67.

Ewald, JA & Touyéras, H (2002)
Examining the spatial relationship between pheasant release pens and grey partridge population parameters. In: *Proceedings of the XXVth International Congress of the International Union of Game Biologists and the IXth International Symposium Perdix*.
Ed: E Hadjisterkotis. *European Journal of Wildlife Research,* 48 Supplement: 354-363.

Griffiths, GJK (2003)
The effect of field boundary type on the community structure, spatial distribution and physiological condition of over-wintering arthropods, with special reference to Carabidae *and* Staphylinidae (Coleoptera). Unpublished PhD Thesis. University of Plymouth.

Holland, JM, Birkett, T, Begbie, M, Southway, SE & Thomas, CFG (2003)
The spatial dynamics of predatory arthropods and the importance of crop and adjacent margin habitats. *Landscape and Management for Functional Biodiversity International Organisation for Biological Control West Palearctic Regional Section Bulletin*, 26: 65-70.

Holland, JM & Reynolds, CJM (2003)
The impact of soil cultivation on arthropod (*Coleoptera and Araneae*) emergence on arable land. *Pedobiologia*, 47: 181-191.

Hoodless, AN, Kurtenbach, K, Nuttall, PA & Randolph, SE (2003)
Effects of ticks *Ixodes ricinus* infestation on pheasant *Phasianus colchicus* breeding success and survival.
Wildlife Biology, 9: 171-178.

Kirby, AD (2003)
*Invertebrate Interaction with red grouse (*Lagopus lagopus scoticus*)*. Unpublished PhD Thesis. University of Sterling.

Laurenson, MK, Normans, RA, Gilbert, L, Reid, HW & Hudson, PJ (2003)
Identifying disease reservoirs in complex systems: mountain hares as reservoirs of ticks and louping-ill virus, pathogens of red grouse. *Journal of Applied Ecology*, 72: 177-185.

Macdonald, DW, Reynolds, JC, Carbone, C, Mathews, F & Johnson, PJ (2003)
The bio-economics of fox control. In: *Conservation and Conflict: Mammals and Farming in Britain*. Eds: FH Tattersall & W Manley. The Linnean Society of London, London. 220-236.

McDonald, RA (2003)
Mammal communication: public understanding and standing of publications. *Mammal Review*, 33: 1-2.

Newey, S, Bell, M, Enthoven, S & Thirgood, SJ (2003)
Can distance sampling and dung plots be used to assess the density of mountain hare *Lepus timidus*? *Wildlife Biology*, 9: 185-193.

Oliver-Bellasis, HR & Sotherton, NW (2003)
Mammals and game management: a farmer's view. In: *Conservation and Conflict: Mammals and Farming in Britain*. Eds: FH Tattersall & W Manley. The Linnean Society of London, London. 30-36.

Potts, GR (2002)
Arable farming: the options for game and wildlife. *Journal of The Royal Agricultural Society in England*, 163: 72-82.

Potts, GR (2003)
The myth of the overwintered stubble. *Bird Study*, 50: 91-93.

Potts, GR (2003)
Balancing bio-diversity and agriculture. In: *Proceedings of the BCPC International Congress - Crop Science & Technology 2003*. 35-44.

Redpath, SM & Thirgood, SJ (2003)
The impact of hen harrier (*Circus cyaneus*) predation on red grouse (*Lagopus lagopus scoticus*) populations: linking models with field data. In: *Birds of Prey in a Changing Environment*. Eds: DBA Thompson, SM Redpath, AH Fielding, M Marquiss & CA Galbraith. HMSO, Edinburgh. 499-510.

Reynolds, JC & Short, MJ (2003)
The status of foxes *Vulpes vulpes* on the Isle of Man in 1999. *Mammal Review*, 33: 69-76.

Sage, RB, Putaala, A, Pradell-Ruiz, V, Greenall, TL, Woodburn, MIA & Draycott, RAH (2003)
Incubation success of released hand-reared pheasants *Phasianus colchicus* compared with wild ones. *Wildlife Biology*, 9: 179-184.

Stoate, C (2002)
Farmers' Management Strategies and the Conservation of Farmland Passerines. Unpublished PhD Thesis. Open University, Milton Keynes.

Stoate, C, Szczur, J & Aebischer, NJ (2003)
Winter use of wild bird cover crops by passerines on farmland in northeast England. *Bird Study*, 50: 15-21.

Thirgood, SJ, Redpath, SM & Graham, IM (2003)
What determines the foraging distribution of raptors on heather moorland? *Oikos*, 100: 15-24.

Woodburn, MIA, Sage, RB & Carroll, JP (2002)
The efficacy of a technique to control parasitic worm burden in pheasants (*Phasianus colchicus*) in the wild. In: *Proceedings of the XXVth International Congress of the International Union of Game Biologists and the IXth International Symposium Perdix*. Ed: E Hadjisterkotis. *European Journal of Wildlife Research,* 48 Supplement: 364-372.

Note: the publications listed as 2002 did not appear in print before the Review of 2002 *went to press. For a complete record of the scientific publications by staff of The Game Conservancy Trust, we therefore include them here.*

Staff of The Game Conservancy Trust

in 2003

CHIEF EXECUTIVE	Teresa Dent BSc, ARAgS
Personal Assistant	Wendy Smith
DIRECTOR OF POLICY AND PUBLIC AFFAIRS	Stephen Tapper BSc, PhD
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Press & Publications Assistant (p/t)	Louise Shervington *(from January)*
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Ecologist - Scottish Lowland Research	David Parish BSc, PhD
Field Officer – Farmland Ecology	Peter Thompson DipCM, MRPPA (Agric)
Research Assistant - Hare Ecology	Jennie Stafford
Head of Fisheries Conservation	Ian Lindsay BSc
Fisheries Research Scientist	Dylan Roberts BSc
Fisheries Biologist (p/t PhD student)	Dominic Stubbing HND, MIFM
PhD student *(King's College)* - Fish Ecology	Ravi Chatterji BSc, MSc
Fisheries Biologist	Reuben Moss BSc
Fisheries Research Assistant	Matthew Parr *(June-September)*
Fisheries Research Assistant	Matthew Shone *(June-September)*
Monnow Project Co-ordinator	Gill Watkins *(from January)*
Monnow Team Leader	Ben Rodgers *(from February)*
Monnow Senior Tree Worker	Oliver Watkins *(from February)*
Monnow Habitat Worker	Philip Howells *(from February)*
Monnow Habitat Worker	Robert Powell *(from July)*
Monnow Habitat Worker	Derek Lloyd *(February-April)*
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
MSc student *(University of Lyon)* - Woodcock	Jean-Philippe Doucet
MSc student *(Reading)* - Waders	Hannah McLauchlin BSc
MSc student *(Reading)* - Gamebird Releasing Studies	Ryan Blyth BSc *(May-July)*
PhD student *(Imperial College)* - Pheasant Releasing Studies	Clare Turner BSc
PhD student *(Reading)* - Gamebird Releasing Studies	Sarah Callegari BSc, MSc
PhD student *(University of Kent)* - Game and Wildlife	Tracy Greenall BSc, MSc
PhD student *(John Moore's, Liverpool)* - Quail Chick Ecology	Dave Butler BSc
Project Ecologist - Energy Crop Studies	Mark Cunningham BSc, MSc
Sandwich students	Austin Weldon *(until July)*, James Grecian *(from June)*
Seasonal Research Assistants	Diane Ling, Louise Stratton
Head of Wildlife Disease & Epidemiology	Chris Davis BVM&S, MRCVS
Game Technician/Stockman	Des Purdy BSc, PhD
Head of Predation Control Studies	Jonathan Reynolds BSc, PhD
Research Assistant	Mike Short HND
Research Assistant	Thomas Porteus BSc, MSc
Head of Entomology	John Holland BSc, MSc, PhD
Senior Entomologist	Steve Moreby BSc, MPhil
Entomologist	Sue Southway BA
Post Doctoral Entomologist	Barbara Smith BSc, PhD
Assistant Entomologist	Tom Birkett BSc, PgC
Assistant Entomologist	Matt Begbie BSc *(until August)*
Seasonal Research Assistant	Rhian Leigh BSc, MSc *(May-December)*
Assistant Entomologist	Heather Oaten BSc, MSc *(from April)*
Seasonal Research Assistants	Tim Bray BA, Chris Andrews BSc
Sandwich students	Sarah Jennings, Catherine Holley, Dan Weaver
Volunteer *(Bournemouth University)*	Chris Fenn
Director of Upland Research	David Baines BSc, PhD
Administrator	Julia Hopkins
Black Grouse Recovery Officer	Phil Warren BSc
Research Assistant - Black Grouse	Michael Richardson BSc
Senior Scientist - Upland Predation Experiment	Robbie McDonald BSc, PhD *(until May)*
Otterburn Scientist - Upland Predation Experiment	Kathy Fletcher BSc, PhD
Research Assistant - Upland Predation Experiment	Robin Foster HND *(from February)*
Gamekeeper - Upland Predation Experiment	Craig Jones
Temporary Gamekeeper - Upland Predation Experiment	Philip Chapman *(March-May)*
Gamekeeper - Upland Predation Experiment	Philip Savage *(until March)*, Danny Lawson *(from February)*
Trainee Gamekeeper - Upland Predation Experiment	Joe Pattison *(from June)*
Senior Scientist - North of England Grouse Research	David Newborn HND
Research Scientist - Raptors	Arjun Amar BSc, PhD *(until April)*
Seasonal Field Assistants	Dafydd Roberts, Catherine Barlow, Kate Blazeby, Pamela Staley, Laura-Anne Taylor
Research Trainees	Rebecca Beeston, Anna Johnson
Senior Scientist - Scottish Upland Research	Adam Smith BSc, MSc, DPhil
Senior Scientist - Woodland Grouse	Isla Graham BSc, MSc, PhD
Ecologist - Mountain Hares	Scott Newey BSc, MSc
Research Assistant - Scottish Upland Research	David Howarth
Upland Research Scientist - Ticks	Alison Taylor BSc, PhD

PhD student *(Stirling)* - Red Grouse Productivity	Alan Kirby BSc, MSc
PhD student *(Edinburgh)* - Muirburn	Matt Davies BSc, MSc
MSc student *(Imperial College, London)* - Red Grouse	Nadine Clark BSc
Mountain Hare Project Laboratory Assistant	Annemieke Visch *(August-September)*
Seasonal Research Assistants	Alan MacLeod, Paul French, Ann-Marie MacMaster, Ross Hunt, Carol Smithard

DEPUTY DIRECTOR OF RESEARCH	Nicholas Aebischer Lic ès Sc Math, PhD
Secretary & Librarian	Claude Gillie CertEd
Grey Partridge Ecologist	Stephen Browne BSc, MSc, PhD
Seasonal Research Assistant - Arable Stewardship	Matt Edwards BSc, MSc *(until March)*
MSc student *(Manchester Metropolitan)* - Grey Partridges	Luke Teague BSc *(May-July)*
MSc student *(Bangor)* - Grey Partridges	Simon Pickett BSc *(May-July)*
PhD student *(Oxford)* - Raptors	Mark Watson BA, MSc
Research Assistant - Biometrics	Rebecca Whitlock BA, MSc *(May-September)*
Head of Geographical Information Systems	Julie Ewald BS, MS, PhD
Research Assistant - GIS	Neville Kingdon BSc
Research Assistant - GIS	Nina Graham BSc
Sandwich Student *(Seale-Hayne)* - GIS	Steffan Jones *(April-September)*
Sandwich Student *(Seale-Hayne)* - GIS	Dan Weaver *(until February)*
Sandwich Student *(Seale-Hayne)* - GIS	Adam Cleal *(until June)*

COMMERCIAL DIRECTOR	Simon Mulcuck *(until August)*
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Regional Organiser	Max Kendry
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Membership Records Assistant: Renewals	Jenny Bowen-Jones
Membership Records Assistant: Donations	Mary Barnes BA
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Finance Assistant - Limited	Lin Dance
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Head of Administration & Personnel	Kate Oliver
Receptionist/Secretary	Joanne Hilton
Head Groundsman	Craig Morris
Caretaker/Janitor	Nicholas Stonehewer *(until March)*
Assistant Groundsman/Janitor	Alan Stone *(April-September)*
Headquarters Cleaner (p/t)	Rosemary Davis
Headquarters Janitor	Paul Pettifer *(February-July)*, Chris Johnston *(from August)*
Head of Information Technology	James Long BSc

DIRECTOR SCOTLAND & ADVISORY SERVICES	Ian McCall BSc[1]
Secretary - Scotland	Irene Johnston
PR & Education - Scotland	Katrina Candy HND
Co-ordinator Advisory Services	Liz Scott[2]
Advisory & Administration Assistant (p/t)	Helen Barker *(February-August)*
Advisor - Central & Southern Scotland & Northern England	Hugo Straker NDA[3]
Advisor - Wales, Midlands	Ian Lindsay BSc[4]
Secretary to Ian Lindsay (p/t)	Mandie Pritchard *(from September)*
Advisor - South of England	Mike Swan BSc, PhD[5]
Advisor - Eastern & Northern England	Martin Tickler MRAC[6]
North of England Advisor & Biodiversity Officer	Mike McKendry ARICS *(from September)*

[1] Ian McCall is also Regional Advisor for Northern Scotland & Ireland; [2] Liz Scott is also Sponsorship Co-ordinator; [3] Hugo Straker is also Development Officer for Central and Southern Scotland; [4] Ian Lindsay is also Head of Fisheries Conservation; [5] Mike Swan is also Head of Education; [6] Martin Tickler is also Eastern Regional Organiser

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, MBPR (Agric)
Secretary (p/t)	Sheena Girvan *(until Feb)*, Alison Tomlinson *(Feb-Nov)*, Rosemary Barker *(from Dec)*
Senior Ecologist & Education Officer	Chris Stoate BA, PhD
Research Ecologist	Kate Draycott BSc
Field Assistants	John Szczur BSc *(Feb-Aug)*, Tristan Norton *(May-Aug)*
MSc Student *(univ?)* - Subject?	Mary Toomey BSc [?] *(Apr-Aug) [?] - check Alastair*
PhD student *(Harper Adams)* - Breeding Songbird Habitat	Kathryn Murray BSc
Game Keeper - Royston	Malcolm Brockless
Farm Manager	Philip Jarvis HND
Farm Assistant	Michael Berg
Sandwich student	Matt Davis HND
Volunteer Field Assistants	Sarah Hodge *(May-July)*, Ed Keyser *(November only)*
Catering Assistant (p/t)	Jeanette Parr

Index of research projects

covered in this Review