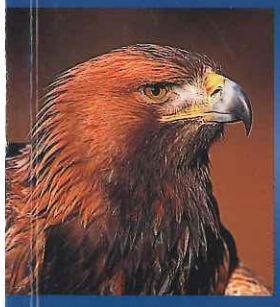
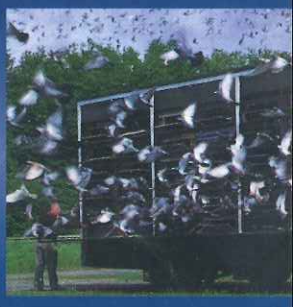
REPORT OF THE UK RAPTOR WORKING GROUP

Chaired by the
Department of the Environment, Transport and the Regions (DETR)
and the Joint Nature Conservation Committee (JNCC)







UK RAPTOR WORKING GROUP

CHAIRS

Dr C.A. Galbraith, Joint Nature Conservation Committee [Co-chair]

R. Groombridge, Department of the Environment (Co-chair) {1995-1996}

C. Tucker, Department of the Environment, Transport and the Regions (Co-chair) {1996-present}

MEMBERS

Dr I. Bainbridge/G.M. Williams, Royal Society for the Protection of Birds

Major E.C. Camilleri, The Confederation of Long Distance Racing Pigeon Unions of Great Britain and Northern Ireland (also representing the Royal Pigeon Racing Association)

J. Clorley, Department of the Environment, Transport and the Regions (Joint Secretariat) {1996-present}

J. Drysdale, Scottish Landowners Federation

A. Laws/A. Semple, British Association for Shooting and Conservation

Prof. J. Miles, Scottish Executive Rural Affairs Department, Environment Group

Prof. I. Newton, Institute of Terrestrial Ecology

Dr G.R. Potts/Dr S. Tapper/Dr S. Thirgood, Game Conservancy Trust

P. Stirling-Aird, Scottish Raptor Study Groups

D.A. Stroud, Joint Nature Conservation Committee (Joint Secretariat) {1996-present}

PAST MEMBERS

T. Emm, Department of the Environment (Joint Secretariat) {1995-1996}

Dr I.M. Evans, Joint Nature Conservation Committee (Joint Secretariat) {1995-1996}

Dr P. Robertson, Game Conservancy Trust {1996-1998}

Department of the Environment,
Transport and the Regions
Tollgate House
Houlton Street
Bristol
BS2 9DJ

Joint Nature Conservation Committee
Monkstone House
City Road
Peterborough
PE1 1JY

Chris Mullin, Parliamentary Under-Secretary of State.

3 February 2000

Dear Minister

In June 1995, the UK Raptor Working Group was established by former Environment Minister, Robert Atkins MP. The remit of the Group was to consider issues arising from perceived conflicts between the recovery of some bird of prey populations and their impact on game birds and moorland management and on racing pigeons.

After receiving and considering information from a wide range of individuals and organisations, as well as from leading authorities and relevant specialists, we are pleased to submit our final report. The report summarises the submissions made to the Working Group, together with other relevant information. The report and its final conclusions and recommendations are presented for your consideration, and have been copied to your colleagues Sarah Boyack, Christine Mather and Sam Foster in the devolved administrations.

The solutions to all the issues under consideration, but especially those relating to birds of prey and grouse moors, will need to involve an integration of different approaches operating at different scales and over varying periods of time.

The Working Group considers that a timetable with clear targets to seek to resolve the current conflicts should be developed. These targets could then be used to judge the success or failure of our suggested approach.

Yours sincerely

Mrs Christine Tucker

Dr Colin A. Galbraith

Report of the UK Raptor Working Group

Executive summary

1 The Raptor Working Group

The Raptor Working Group was established by the former Department of the Environment (now the Department of the Environment, Transport and the Regions – DETR) in 1995 following a meeting of parties interested in the implications of the growth of raptor populations. The Working Group's Terms of Reference were to: consider population status of birds of prey; identify species alleged to be causing problems; identify, in particular, the impact of such species on game birds and moorland management and on racing pigeons; identify gaps in research and future needs, and identify possible sources of funding; and consider statutory and other mechanisms for the resolution of problems.[1] The Group has met 25 times, received a large number of submissions, and had discussions with the national Forum of interested parties in 1996, 1997 and 1998.

2 Status of birds of prey

The Group has reviewed the numbers and trends of UK populations of birds of prey. The UK has particular international obligations for the conservation of its bird of prey populations: 11 of the 16 UK species are listed as UK Red Data birds. Whilst some species have recovered from earlier declines caused by killing by man (which has been completely illegal since 1954), or by the effects of persistent organochlorine pesticides, most have not yet fully recovered their former range or numbers. Two species (sparrowhawk and kestrel) are known to be declining nationally.

Generally there is good information on breeding population sizes of all British raptor species with systematic monitoring in place. The intensity of bird surveys in the UK is unparalleled in the world. We have reviewed the available data, and concluded that there is a sound basis for making recommendations to government on the conservation management of British birds of prey. This has enabled the Group to make objective assessments of bird of prey populations, and the problems attributed to them. There are some gaps, however, and we have made recommendations concerning desirable enhancements to monitoring activity for some species.

Results of a national hen harrier survey in 1998 showed no change in national numbers over the previous decade, although there have been some increases and decreases in different countries and regions. Overall, however, the hen harrier remains in an unfavourable conservation status in the UK. In England, breeding is restricted to a few sites where active protection measures are in place.

In the four years since the establishment of the Working Group in 1995, there have been 371 confirmed reported incidents in Britain of illegal killing of raptors. These reported incidents probably reflect only a very small proportion of the total incidents that actually occurred in this period. There is evidence that this activity has limited both the distribution and numbers of hen harriers, golden eagles and red kites below levels they would otherwise achieve. The number of incidents relative to national population size is greatest for hen harrier, followed by red kite, white-tailed eagle and peregrine. Hen harriers are considered at risk of extinction as a breeding species from England. In both England and Scotland, there is strong evidence of adverse impacts on numbers and productivity associated with illegal killing on grouse moors.

We have recommended enhanced enforcement of existing legislation to seek to eliminate illegal killing of birds of prey. Such enforcement would underpin efforts to encourage game managers, and others, to pursue legal options of enhancing game stocks by other means. There is a range of measures relating to better co-ordination of activities that could be put in place rapidly. We have recorded our general sympathy with the recommendations made by the Partnership against Wildlife Crime (PAW) relating to a range of enforcement and legislative issues. The specific PAW recommendations are, however, for government to take forward in their detail. Legal measures alone, however, are unlikely to solve these issues, and we outline below a range of positive measures that seek to resolve the current conflicts.

3 Birds of prey and grouse moors

There has been a long-term and extensive loss of heather moorland throughout the uplands. A fundamental issue is the loss of nearly a quarter of all heather moorland in Scotland in just 40 years. This has been caused by agricultural intensification, afforestation and overgrazing. In the light of the importance of grouse moors for the upland rural economy, including fragile human communities, as well as for nature conservation and wildlife, there is a proportionate need to restore the quality and extent of heather moorlands. We suggest a national campaign to help focus attention on heather moorland restoration, linked to the Habitat Action Plan for Upland Heathland – part of the government's biodiversity conservation initiative.

[1] Hansard 8 June 1995, WA 97-98.

There are significant differences with respect to grouse shooting between Scotland, England, Wales and Northern Ireland. Over the last 50 years Scottish, but not English grouse bags have declined. In the last ten years, grouse densities on monitored moors have not declined in either country. Since 1950, 127 heather moors in Scotland – 30% of the total – have ceased to be managed for significant sport shooting of red grouse, but only 50 have ceased in England. In Wales and Northern Ireland, management of moorland for red grouse has virtually ceased. Widespread overgrazing in the uplands, especially by sheep but also by red deer in Scotland, has had major ecological impacts on many heather moorlands and other upland vegetation types, particularly in Wales and parts of Scotland. Thus there are a variety of factors that point to grouse moors in Scotland, for several reasons, being less intensively managed and of lower viability than those in England. This influences priorities in addressing the current situations, with continued emphasis needed to be given to moorland management in Scotland.

There is a substantial body of information on the ecology of grouse and grouse moor management. In many areas, grouse bags have shown a long-term decline for much of this century for reasons unconnected with raptors. These are probably linked to quality and quantity of habitat, and intensity of moorland management. The current low level of harvestable grouse in some areas is such as to reduce significantly the viability of driven grouse shooting on some moors. After 1990, at Langholm, autumn red grouse stocks were significantly reduced by raptor predation, at a time when grouse stocks were low and raptor densities were high. This affected red grouse bags and, subsequent to the study, spring densities at Langholm were reduced and driven grouse shooting was suspended. To what extent this pattern would be repeated on other moors is not known. The fear that this would be a widespread pattern undoubtedly fuels much of the persistent illegal killing of birds of prey on grouse moors. Such concerns are a major impediment to the development of the active partnerships that are so urgently needed between conservationists, and others living and working in the uplands (as well as the lowlands).

The Group suggests that much of the long-term solution to the current problems faced by grouse moor owners lies in the need to restore and enhance the extent and quality of heather moorland. There is an important need for dissemination of 'best-practice' guidance relating to management techniques that will optimise grouse production and biodiversity. Further steps should be undertaken in the context of a national campaign to restore heather moorlands rich in grouse and associated wildlife – including birds of prey. No incentive scheme exists that is specifically designed to encourage the restoration of heather moorland, or is targeted at heather moors aside from their agricultural uses. Future development of incentives for encouraging good moorland management, and the sharing of good practice from existing, well-received schemes that encourage good moorland management, will be important. A new specific incentive scheme for heather moorland would be ideal; however the refocusing of existing schemes to include additional elements that encourage good moorland management is a more realistic short-term objective.

The Group has considered all possible immediate options to resolve raptor-grouse conflicts. Only a few of the measures that are theoretically possible to alleviate problems would be legal without a licence, and consequent derogation from the EEC Wild Birds Directive (EC/79/409). Diversionary feeding of birds of prey during important periods of grouse vulnerability is within the law provided there is no disturbance of the birds of prey. Results of trials in Scotland, under the auspices of Scottish Natural Heritage's Moorland Working Group, involving the feeding of hen harriers in 1998 and 1999 were successful and diversionary feeding is a technique that should be widely promoted as a means of greatly reducing hen harrier predation on red grouse during critical periods. It would be an effective short-term measure before achieving a longer-term solution, possibly based on habitat restoration. Trials of diversionary feeding of peregrines on grouse moors should be undertaken.

Other options involve a range of legal impediments, given the unfavourable conservation status of the UK hen harrier population and varying, but greater degrees of intervention, with consequent impacts on hen harrier populations. The EEC Wild Birds Directive allows lethal control as a legal option only in particular circumstances. Any derogation for lethal control would need to consider a range of factors and would have a very high public profile. Thus, in the current circumstances, where not all other satisfactory solutions to conflicts have been tried, the Working Group has ruled out lethal control of raptors. Similar legal issues apply to species management options for other birds of prey in the context of moorland conservation.

The Group concludes that it is timely that conservationists, grouse moor owners and gamekeepers should all realise that they share many common objectives. All share concerns for the future of the uplands. There are many clear signs of this common thinking developing within the Moorland Working Group in Scotland, and similar dialogue is needed in England, Wales and Northern Ireland. This will give an opportunity to show that on heather moorlands there is the potential to integrate the management of grouse with the conservation of the natural environment, to produce and maintain a high quality of life for residents and visitors alike.

4 Birds of prey and racing pigeons

The sparrowhawk and peregrine are the two species of bird of prey that most frequently interact with racing pigeons. Goshawks also occasionally kill pigeons. There are two problems primarily associated with raptor predation on racing pigeons – raptors killing pigeons whilst training and racing, and raptors killing pigeons whilst exercising around lofts. Evidence of the precise circumstance and scale of losses to raptors has been obtained by a DETR commissioned research project, together with surveys undertaken by the Scottish Homing Union and the Royal Pigeon Racing Association.

Losses to raptors are just one cause of the mortality of racing pigeons, and we note that pigeon fanciers accept that their sport carries a degree of risk from attacks by predators. Accordingly, data and information on the different causes of failure of pigeons to return to lofts will be important in the development of a strategy to resolve problems. We note that there is no legal provision in the UK for the killing of raptors which take liberated racing pigeons.

The Group has thus concluded that there is a clear need for the development, testing and scientific evaluation of the effectiveness of deterrents at the loft, and during the training and racing of pigeons. There are other techniques that may reduce losses during racing, and these need to be fully evaluated. It is clear that no single technique will solve these problems since they are caused by several species of raptor, and their intensity varies in different places and at different times. A range of measures will be needed to address the separate issues of predation at lofts, during training and on races.

Priority attention should be given to understanding the causes of straying during racing, especially for young birds. Minimising straying is likely to be the single most effective way of enhancing pigeon return rates. Consideration should also be given to delaying the start of the 'old bird' racing season in order to avoid the current coincidence with the start of the peregrine's breeding season, as well as to re-organising race routes, especially for young bird racing, in an attempt to establish 'flight corridors' and reduce the current complexity of north/south and east/west 'crossovers' in the flightpaths of pigeons during racing.

Different techniques should be refined progressively as experience and knowledge develops. The development of sound scientific studies, undertaken as collaborations between the racing pigeon community, academic institutions and, where appropriate internationally, would help derive effective long-term measures to reduce the scale of losses currently experienced both at lofts and during racing or training.

5 Birds of prey and lowland gamebirds

Sparrowhawk, buzzard, tawny owl and goshawk have been identified as preying upon pheasants and partridges. However, in the context of the total number of gamebirds released, losses are minimal. There are localised problems, particularly related to predation around pheasant release pens.

Whilst there has been some previous research on means of deterring predators at release pens in the 1970s, the Group has initiated further work to establish an objective approach to deterrence and other preventative measures, and to enable game and conservation bodies jointly to disseminate clear advice on best practice. The study will report in 2000.

6 Birds of prey and songbirds

It has been suggested that the recovery of some birds of prey has caused declines of formerly common farmland birds. Although the declines of many formerly common songbirds have coincided with the recovery of sparrowhawks, on the basis of a range of evidence presented to the Working Group, we have concluded that there is no scientific evidence that birds of prey have affected population levels of British songbirds. These declines are rather a consequence of changing types of lowland agriculture.

7 Integration of solutions

The Group considers that solutions to these issues involve a combination of different approaches, working at different scales, and over varying time periods. Given the contributions that properly conducted field sports and game conservation make towards the maintenance and enhancement of the natural heritage, and towards rural employment, partnerships need to be established and maintained between all interested bodies in order to develop and implement solutions. The Group welcomed the document *Action for Scotland's moorlands: a statement of intent* signed by 14 organisations in 1998, which was one outcome of the formation of the Moorland Working Group in Scotland. Such shared goals are a useful step towards achieving sustainable solutions. There is scope for similar such initiatives elsewhere in the UK, and we have recommended that the statutory conservation agencies in England, Wales and Northern Ireland consider a means of sharing expertise, and exchanging of information and good practice between those involved in the conservation and management of heather moorland.

The issues raised by raptor predation remain contentious and will not be resolved easily. The Working Group considers that we will need better education, a public awareness of the problems, and a focus on best practice by those concerned with management of gamebirds and racing pigeons. We have made recommendations in these areas.

Compatibility between conservation and game management cannot be left to evolve by default: it must continue to develop by design – with the due support that it so rightly deserves from all interested parties.

Contents

Annexes

1 Introduction, background and Terms of Reference of Working Group

Birds of prey (or raptors[1]) are of special importance for the bird conservation movement in the UK. As they occur at the top trophic levels of foodwebs, throughout the world birds of prey are sensitive environmental indicators, especially of habitat quality and the presence of persistent chemicals in food chains. As such, they are important components of natural biodiversity.

It is probable that most birds of prey were formerly widespread across most of the UK in early historical times (before formal records existed) although, by the last quarter of the 19th century, the distributions and populations of many raptors had been limited greatly by killing and egg collecting (Holloway 1996). Indeed, five of the 15 species of birds of prey in Britain became extinct in Britain around the beginning of the 20th century.

Populations recovered as a result of the lessening of killing, initially during the First and Second World Wars[2], when gamekeepers were employed elsewhere, and subsequently also as a result of protective legislation. Some species declined further as a consequence of the widespread use of persistent organochlorine pesticides in the 1950s and 1960s. Although there have been subsequent recoveries following curbs on the use of these chemicals, a few species have more recently shown declines – probably as a consequence of the intensification of lowland agriculture and of habitat degradation in the uplands.

Today, 11 of the 16 UK species are listed as Red Data Birds – an indication of the particular ecological sensitivity of this group of birds – and all are listed on the UK 'long' list of species for which Biodiversity Action Plans are, or will be, implemented (Biodiversity Steering Group 1995). Of these, six are listed as of high conservation concern in the *Birds of Conservation Importance* and *Birds of Conservation Concern* evaluations published by the statutory agencies and Non-Governmental Organisations (NGOs) in 1996 (JNCC 1996; RSPB *et al*. 1996). The relevant negative factors resulting in this status are significant historical declines in numbers and range, small current breeding populations, and global ranges which are concentrated in Europe yet being in unfavourable conservation status.

British birds of prey have thus experienced a series of human-induced impacts and most have yet to recover fully their potential distributions. The recovery of populations has been the result of hard-fought conservation advocacy in the past (*e.g.* Brown 1964; Moore 1987) and, as a consequence, they have become a *cause célèbre* for the conservation movement as a whole.

Heather moorland managed for red grouse is a landscape of importance, not only for rural communities in the uplands but also for nature conservation. Despite the economic importance of these areas, at least since the Second World War there has been a slow attrition in the extent and quality of the national heather moorland estate. In significant part, this has been a consequence of the economics of alternative upland land-uses, such as afforestation and sheep farming, resulting in either the direct loss of heather moorland or the degradation of its quality. There also has been a long-term trend to manage heather areas less intensively. Significant areas of heather moorland (including grouse moors) are now either poorly managed, or are in sub-optimal condition for both grouse production and nature conservation. Such poor management exacerbates other problems.

During the early 1990s, the then Department of the Environment was made increasingly aware that the recovery of the populations of certain birds of prey was believed by some parties to be having an adverse impact on some gamebirds and also on racing pigeons. Against a background of long-term declines in grouse numbers, some of those managing grouse moors asserted that current levels of predation by hen harriers, peregrines and some other birds of prey – the numbers and distribution of which had recovered or increased compared to recent decades in the uplands – were reducing the economic viability of their operations. Very large numbers of the public, however, actively support nature conservation organisations. Conservation-related activity brings significant economic benefits to rural areas, partly through tourism; however, revenue flows are such that those landowners suffering significant economic losses from protected wildlife do not usually gain from such conservation-related activity.

Those who raced pigeons asserted that the recovery of UK sparrowhawk and peregrine populations was such as now to be resulting in unacceptable losses of pigeons to these raptors. This mortality occurred either during training, on races or closer to lofts.

[1] Throughout this report, the terms bird of prey, or raptors, are used to mean all birds of the order Falconiformes, which are found in the UK. This comprises osprey, hawks, kites, buzzards, eagles and falcons. We include also tawny owls owing to its relevance (in certain situations) to lowland game management (Section 5).

[2] Legal killing of peregrines under the Destruction of Peregrine Falcons Order 1940 occurred during the Second World War in some parts of Britain, in order to protect homing pigeons released by airmen who had crash-landed when on sea-patrol off western and north-eastern Britain (Ratcliffe 1993).

Finally, various lowland game interests asserted that high mortality of lowland game, mainly pheasants, at or around release pens was a consequence of raptor predation.

An apparent consequence of all of these conflicts was that some individuals were illegally killing raptors – possibly in increasing numbers – in search of local solutions. As a result, on 24 April 1995 the Department was host to a Forum of interested parties to discuss the recovery in the populations of certain birds of prey, and their impact on game bird management and racing pigeons. A list of those organisations that attended that or subsequent meetings is given in Annex 1.

There was a clear outcome from the Forum – to set up a Working Group to develop a more detailed strategy and identify gaps in existing knowledge. The main Forum itself would meet about once a year. Details of the membership and Terms of Reference of the Working Group were announced by Robert Atkins, former Environment Minister, in answer to a Parliamentary Question on 8 June 1995[3]. They are to:

"1 *consider population status of birds of prey;*

2 *identify species alleged to be causing problems;*

3 *identify, in particular, the impact of such species on game birds and moorland management and on racing pigeons;*

4 *identify gaps in research, and future needs, and identify possible sources of funding; and*

5 *consider statutory and other mechanisms for the resolution of problems.*"

At its first meeting, the Working Group agreed that it was necessary to interpret the third Term of Reference broadly, and thus to identify, in particular, the impact of raptor species on game birds and moorland management, and on racing pigeons and other species, in the context of land management of all habitats.

In the light of the wide public interest in the alleged role of birds of prey in the decline of some formerly common farmland birds, the Group has also briefly considered these issues (Section 6) even though the topic was not a formal Term of Reference.

The Group has met a total of 25 times (Annex 2) and annually reported to three further meetings via a Forum of interested parties. Its membership was selected with the intention of encompassing the range of interests involved in the raptor issue through key representative organisations. It is chaired jointly by the Department of the Environment, Transport and the Regions (DETR) and the Joint Nature Conservation Committee (JNCC). Its membership consists of: the British Association for Shooting and Conservation (BASC), Institute of Terrestrial Ecology (ITE), the Confederation of Long Distance Racing Pigeon Unions of Great Britain and Northern Ireland (also representing the Royal Pigeon Racing Association – RPRA), Royal Society for the Protection of Birds (RSPB), Scottish Landowners' Federation (SLF), the Game Conservancy Trust (GCT), Scottish Office (now Scottish Executive) and the Scottish Raptor Study Groups.

Those individuals who have contributed as members of the Group are listed in Annex 2.

1.1 Government commissioned research

At an early stage, JNCC and the Scottish Office commissioned from ITE a literature review to assist the Working Group in providing a synthesis of facts on red grouse management, pigeon racing and predation by raptors. Its aim was to provide a basis for identifying future research requirements that would help clarify the impact of raptors on red grouse and racing pigeons, and thereby allow the Working Group to consider options for the resolution of the issues. The specification and summary of this review (Hinsley & Redpath 1996) is given in Annex 5.

DETR commissioned two studies to support the work of the Group: firstly, a study of raptor predation of red grouse as influenced by moorland management practices; and secondly, a study of raptor predation of domestic pigeons.

The first of these studies, which was published in 1999, was undertaken by the GCT and the ITE. Its specification and the executive summary of the final report (Smith & Campbell 1999) are given in Annex 6.

The second research contract (Annex 7) was undertaken by the Hawk and Owl Trust and the final report was also published in 1999 (Shawyer *et al*. 1999). The executive summary of this report is presented in Annex 7.

The Scottish Raptor Study Groups collated a report, with support from the Scottish Office, to provide context on current levels of illegal killing of birds of prey. This was submitted to the Working Group (Scottish Raptor Study Groups 1998; summary in Annex 9), and this was supplemented by reports from Raptor Study Groups in northern England and a comprehensive review of the current extent of illegal killing in England (Holmes *et al*. 2000).

The Group developed a proposal for research into issues relating to predation of pheasants at release pens – both problems and management needs (Annex 8). This work began in 1998 with funding from BASC, DETR, SNH, National Trust and the RSPB. The contract was awarded to the Agricultural Development and Advisory Service. An interim report was produced in 1999 and the final report will be published in 2000.

[3] Hansard 8 June 1995, WA 97-98.

1.2 Other research and evidence submitted to the Working Group

Seven other pieces of work derived directly from the deliberations of the Working Group and were undertaken by others:

- The Royal Pigeon Racing Association undertook a questionnaire survey of its members to assess levels of mortality associated with birds of prey (RPRA 1996).
- BASC undertook a survey of gamekeepers to identify which raptor species are causing concerns to game managers and why; and to investigate the extent of current problems, and efficacy of solutions, to bird of prey predation associated with aspects of lowland game management (Harradine *et al*. 1997).
- The Scottish Homing Union presented the findings of its membership survey on the impacts of birds of prey on racing pigeons in Scotland (Scottish Homing Union 1998).
- RSPB, with the formal support of the Raptor Working Group and many other bodies, developed proposals for a national survey of hen harriers which was undertaken in 1998 (Sim *et al*. 1999).
- The GCT has developed its own proposals for hen harrier management to increase the numbers of hen harriers whilst preserving the viability of grouse moors (Watson 1998; Game Conservancy Trust 1998).
- The Group requested RSPB to prepare a summary report giving background to eight instances of the poisoning of re-established red kites in Scotland in 1997 and 1998 (Morton *et al*. 1998).
- Information on trends in poisoning and other methods of illegal killing were requested from RSPB (Morton *et al*. 1998; RSPB 1999a, 1999b).

There were 12 oral presentations to the Working Group. These were made by the following: Scottish Homing Union (on predation on racing pigeons), ADAS (on behalf of the government's Campaign against Illegal Poisoning), the British Trust for Ornithology (on birds of prey and songbirds in the lowlands), the Heather Trust (on moorland management issues), the JNCC Uplands Lead Agency (on the Biodiversity Action Plans for upland habitats), English Nature and the Farming and Rural Conservation Agency (on a range of issues related to upland agri-environment schemes and other incentive mechanisms), RSPB (on the 1998 hen harrier survey results). Additional presentations were made by the Hawk and Owl Trust and ITE/GCT on the findings arising from respective commissioned research into pigeon predation by raptors and moorland management for grouse.

Details of these and the 121 other written submissions presented for the Group's consideration by interested parties are given in Annex 3.

2 Population status of birds of prey in UK

2.1 Population status and trends of birds of prey

This section reviews current knowledge of the sizes of bird of prey populations, the historical trends, relevant national and international conservation contexts, the adequacy of current and proposed population monitoring, the extent of illegal killing and its consequences for the populations concerned.

Historical background

Birds of prey have had a chequered history in the UK. Whilst in mediaeval times some species were subject to strict protection as a consequence of their role in high status sports such as falconry (Yapp 1982; Ratcliffe 1993), the rise of Victorian game shooting led to their increased persecution in the 19th century. The resulting major population declines which led to national extinctions for some species resulted in enhanced legal protection from 1880 onwards, and consequential slow recovery of populations. Whilst, however, there was local provision (at county and county borough level) for the protection of birds of prey under the 1880 Wild Birds Protection Act (Marchant & Watkins 1897), UK-wide protection for all birds of prey (except sparrowhawk) occurred only following the 1954 Protection of Birds Act. This Act established the principle of special penalties for the killing of rarer species.

In the 1950s and 1960s there were significant negative impacts from the accumulation of persistent organochlorine pesticides in food chains (Newton 1979, 1986, 1998), events of major nature conservation attention and public concern (Carson 1965; Arvill 1967; Moore 1987). At this time, sparrowhawk was given protection by Statutory Order in 1963 following its widespread decline. As the impacts of these chemicals were properly understood, their use was prohibited or otherwise widely restricted in the UK (Moore 1987). This led to a slow recovery of range and numbers of the most affected species. The detection of persistent organochlorine pesticides in food chains through their effects on birds of prey, and the consequent events leading to recovery, has been a *cause célèbre* for the conservation movement.

Illegal killing of birds of prey (and the collecting of their eggs) however, continues to affect some populations as discussed below even though these activities have been illegal for most species for over 100 years.

In 1979, both the Berne Convention and the EEC Wild Birds Directive (EC Directive 79/409 on the Conservation of Wild Birds) came into force. These international treaties established a variety of legal principles regarding the protection of threatened birds, including requirements for site conservation, and the regulation of taking and killing. To bring UK domestic legislation into line with these international obligations, in 1981 the Wildlife and Countryside Act was passed (for Great Britain), and in 1985 the equivalent provisions came into force in Northern Ireland through the Wildlife (Northern Ireland) Order.

In the 1990s, there have been several Statutory Instruments to reflect better the provisions of the EEC Wild Birds Directive in domestic legislation.

2.1.1 Estimating bird population sizes

Unless an animal population is extremely small, or occupies a restricted area, it is generally not possible to know *exactly* how many individuals it contains. Aside from the challenge of actually locating all the individuals – which, especially for birds that are highly mobile or occupy wide ranges, can be very difficult – there are the complicating processes of immigration and emigration (the exchange of individuals with other populations), as well as the ongoing process of individual deaths and seasonal births within the population. Thus the precise number of individuals in the population is constantly changing, to a greater or lesser extent, according to time of year. To contend with these problems, a number of conventions are normally employed in the estimation of numbers in a population.

During winter, many birds disperse from breeding areas to other habitats, or greatly extend their foraging range to locate adequate food resources. For this reason, population estimation at this time is extremely difficult, since birds occur in locations that are not always predictable and occur generally at low densities. In contrast, in the breeding season, many birds defend a nesting territory (containing either food resources, or a nest site, or both). This, and the fact that knowledge of the reproductive component of a population (that is numbers of breeding pairs) is fundamental to any understanding of population dynamics, means that the focus of research and survey has generally been on the estimation of breeding numbers.

Complete census coverage

Many birds of prey use the same nesting sites or areas year after year. For the larger birds of prey, in particular, the traditional nature of these sites means that they can be visited by observers each year, and the number of occupied sites can be counted. If knowledge of the location of traditional nest sites is good, and population sizes are small (generally less than 500 pairs), and it can be arranged that all the potential sites are visited in a single breeding season, then it is possible to ascertain accurately the total number of breeding pairs in the population. Good examples of such 'complete coverage' surveys for birds of prey in the UK are the periodic complete national censuses of golden eagle (Dennis *et al.* 1984; Green 1996) and of peregrine (Ratcliffe 1984; Crick & Ratcliffe 1995). These species have the largest populations amongst those for which complete censuses are undertaken. Other complete censuses are carried out for ospreys, red kites and white-tailed eagles (Ogilvie *et al.* 1999a, 1999b), and formerly for marsh harriers (although increased numbers in recent years means that complete annual coverage is no longer practical).

Sample surveys

Other species use less traditional sites (such that our knowledge of their locations is poorer), or occur in greater numbers (generally between 500 and 1,500 pairs). This means that the aim of counting *all* breeding pairs nationally in a single season is less realistic. In such circumstances, the approach adopted is to survey thoroughly a *sample* of the breeding range, and then to extrapolate to total numbers. The precision of such extrapolated estimates can be greatly enhanced if the original sampling is undertaken on a 'stratified' basis – that is, in accordance with features of habitat or distribution which are known to be major determinants of breeding numbers. Good examples of such sample surveys are the national estimates that have been obtained for merlins (Bibby & Nattrass 1986; Rebecca & Bainbridge 1998) and for hen harriers (Bibby & Etheridge 1993; Sim *et al*. 1999). From such methods, sound national population estimates can be derived, together with confidence limits, without the need to count every potential nesting area.

National Atlas surveys

Another frequently used approach for species that are more abundant (>1,500 pairs) is to estimate national numbers based on national atlas survey data. The two national breeding bird atlases (Sharrock 1976; Gibbons *et al*. 1993) have recorded the distribution of bird species on a 10 x 10 km grid. Using information on average densities within these 10-km grid squares, it is possible to extrapolate national population estimates. As with sample surveys described above, these values will not be precise counts of every breeding pair, but will be an estimate with 'confidence limits' – that is an indication of the range within which there is a defined statistical probability that the true, but always unknown, population size will occur. Such techniques have been used to provide our current national estimates for buzzard, kestrel and sparrowhawk (Table 2.1). The fieldwork for the next national breeding atlas is currently anticipated to begin in 2008.

Non-breeding birds

In the autumn, numbers are enhanced by the presence of young of the year. In addition, at all times of the year, non-breeding birds are present which were born one or more years previously and have not yet started to breed. These unattached birds form a component of overall population numbers. It is, however, extremely difficult to assess accurately the numbers of these birds: unlike breeding birds, these individuals do not hold territories and thus are hard to locate and count (even on a sample basis). In addition, young birds suffer higher mortality than older birds such that the total number of unattached birds will decline significantly month by month over the course of the winter.

The only published assessments of the number of unattached birds are those of Newton (1986) who estimated that for female sparrowhawks in the breeding season, unattached birds comprised an additional 43% of the population.

Trends

Information on trends in populations – changes over time – also derives from a number of sources. Simplest is the comparison of two or more national surveys undertaken at different times. For more abundant birds, the comparison of yearly changes in numbers on a network of survey plots allows the calculation of a population index. This is the basis of the long-standing BTO/JNCC Common Bird Census (Marchant *et al*. 1990) as well as the more recent BTO/JNCC/RSPB Breeding Bird Survey (Gregory *et al*. 1997, 1998) – which uses broader, more repeatable survey methods. Both these schemes develop an annual index of population change which helps show the overall trends in the absence of an annual population census.

The UK is uniquely fortunate in having many enthusiastic volunteer birdwatchers, with co-ordination facilitated by funding from the statutory agencies and NGOs. The activity of these bird watchers is mostly self-funded. Such intensity of survey is unparalleled elsewhere in the world (HMSO 1994), and unparalleled for any other group of animals. Yet, despite the efforts of these volunteers, our knowledge is not perfect. While some would like to have a complete count of every bird population every year, for both logistical and financial reasons, this is not possible.

In the context of birds of prey, the rest of this section outlines our current state of knowledge. For each species, we have a reliable national population estimate based on breeding season surveys of territorial pairs (Table 2.1), with knowledge of past distribution, trends and abundance (Annex 4, Tables 2.2). There is in place a programmed national timetable of surveys and monitoring (Table 2.4) that will effectively update this information on a regular cycle.

We have reviewed the available data and have concluded that there is a sound basis for making recommendations to government on the conservation management of British birds of prey. The scale of the information available gives us

confidence that such recommendations are soundly based, even though there are gaps and more data and information would always be useful.

2.1.2 Raptor population sizes and trends

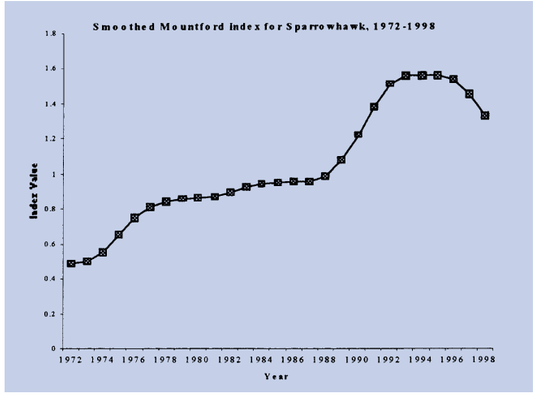
Table 2.1 shows the current status of birds of prey in the UK using data and information drawn, where possible, from published sources. Unpublished reliable sources were only used where published information was not available, or was known to be out of date. Following ornithological convention, where possible we have indicated the number of birds at times of year when populations are at lowest levels (the start of the breeding season), and included information on any non-breeding population segments (although generally such latter information is very scarce and extensive searches located few data). In the immediate post-breeding period, peak numbers of birds of prey will be greater than these estimates owing to the numbers of fledged young and other non-breeding individuals. Many of these young birds will die of natural causes during their first year of life. Notable in the table is the fact that many species still retain a fragmented, and much reduced distribution across the country, in most cases as a consequence of past and continuing illegal killing by humans (section 2.3).

In recent decades numbers of all British birds of prey have been recovering from the low levels caused by killing, before it became illegal, and from organochlorine contamination in the 1950s and 1960s (Table 2.2; Annex 4).

- The hobby (which is migratory) is the only species that could be showing a true population increase, rather than a recovery, throughout its UK range.

Figure 2.1

National trends in sparrowhawk numbers as indicated by the Common Bird Census (smoothed Mountfort Indices from 1972-1998). Data courtesy of BTO/JNCC Partnership. (The Mountford method compares abundance on survey plots across all pairs of years in the series, and uses differences from the overall mean to derive an annual index of abundance. Values are smoothed using a standard statistical procedure to reduce the influence of short-term fluctuations.)



- Overall, the peregrine is at the highest known population level this century, although it is declining again in some areas (Table 2.1a).
- Although our most common raptor, the kestrel is in widespread decline nationwide. CBC and BBS trends indicate national declines (Figure 2.2), beginning in the late 1970s (coincident with the onset of declines in several formerly common farmland birds – Campbell *et al*. 1997).
- For the sparrowhawk the situation is complex (Figure 2.1). In the last 40 years the population has shown decline (following organochlorine impacts), significant recovery (following restrictions in organochlorine use) and, more recently, another decline from about 1992 (Newton *et al*. 1999; Annex 4) associated with declines in prey abundance.
- The results of the 1998 breeding hen harrier survey (Sim *et al*. 1999) found similar overall UK/Isle of Man numbers (570 territorial pairs) compared to 1988 but with some regional changes. Whilst numbers in Orkney have declined significantly (from 71 to 34 breeding territories – see Meek *et al*. 1998), numbers in Northern Ireland have increased from ten to 38. The total in Scotland outside Orkney has not changed.
- The best estimate of buzzard populations (Table 2.1), drawn from the 1988-1991 BTO breeding bird atlas (Gibbons *et al*. 1993), is thought to be too low given the recent recovery of buzzard breeding range in the English Midlands (Sim *et al*. in press), elsewhere in England, and in east and south Scotland (Holling & McGarry 1994). There are currently, however, no better data on numbers. There has been an increase in the national Breeding Bird Survey index of abundance in the five years between 1994 and 1998 (Noble *et al*. 1999).

Although some species were probably never numerous in the UK because of their ecological requirements (as thinly dispersed top predators), six species of raptor found in the UK now have populations of fewer than 300 pairs (honey

Figure 2.2

National trends in kestrel numbers as indicated by the Common Bird Census (smoothed Mountfort Indices from 1972-1998). Data courtesy of BTO/JNCC Partnership.

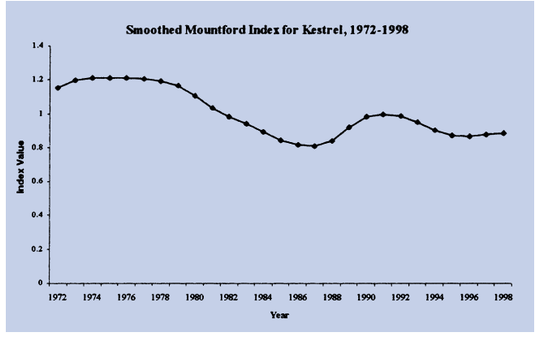


Table 2.1

Best-estimates of sizes of breeding population for birds of prey in the UK. Note that in the post-breeding season, total numbers of birds of prey will be greater than these estimates owing to the numbers of fledged young and other non-breeding individuals. Heavily shaded squares indicate no breeding population.

Species	Units of estimation	**UK**	Scotland	England	**Wales**	Northern Ireland	Isle of Man	Date of estimate	Unattached non-breeding birds	Medium-term trend (since 1970s) **[see Annex 4 for more detailed information]**	**Short-term trend (1990s)**
Honey buzzard	Pairs	12-34[1] Poor data, possibly 50-60[16]	1[1]	12-34[1]	Minimum 1[2]			1997[12]		Slow recovery in numbers and range	Very slow recovery in numbers probably obscured by under-recording[16]
Red kite	Pairs	231-265[1]	23-27[1]	57-61[1]	151-177[1]			1997[1]		Very slow recovery of Welsh population	Populations in England and Scotland derived from re-establishment programmes and rapid expansion; slow continued recovery of Welsh population
White-tailed eagle	Pairs	13-15[1]	13-15[1]					1997[1]		Re-establishment of Scottish population 1975-1998	Slow consolidation of re-established Scottish population
Marsh harrier	Females	128-150[1]	1-4[1]	127-145[1]	0-1[1]			1997[1]		Recovery following virtual elimination consequent upon pesticide induced impacts in late 1960s	Continued recovery of population
Hen harrier	Territorial pairs	570 (499-640)[3]	436 (331-472)[3]	19[3]	28[3]	38[3]	49[3]	1998[3]		Recovery of range and numbers as recolonisation of Scotland and England continued until late 1980s	UK population range and numbers unchanged between 1988-89 and 1998 but recent declines in Orkney and England, and increases in Northern Ireland and Isle of Man
Montagu's harrier	Females	9-12[1]		9-12[1]				1997[1]		Recovery from mid 1970s when no breeding occurred	Probably stable, but with much between-year variability in breeding numbers and young produced
Goshawk	Pairs	400-450[4,5]	89[1]	120[4]	200-250[4,5]	1[5]		1997[1] 1994[4,6] 1993[5]		Recovery of numbers and range following re-establishment 1950s-1970s.	Continued slow recovery in numbers and range
Sparrow-hawk	Pairs	34,500[7]	7,000[7]	22,000[7]	3,000[7]	2,500[7]	50[7]	1988-91[7]	43% of females in breeding season[17]	Recovery of population range and numbers following impacts of organochlorine pesticides in 1960s	Since apparent peak numbers around 1990, national declines noted[15] from survey and CBC trend (Annex 4)
Buzzard	Pairs	12,000-17,000[7,8]	4,500-6,500[7]	4,000-6,000[7]	3,500-4,500[7]	150[7]		1988-91[7] 1983[8] See note **a** below		Slow recovery and consolidation of range and numbers in western Britain	More rapid recovery of numbers and range eastwards possibly in response to lessening illegal killing in the lowlands

Table 2.1 continued

Species	Units of estimation	UK	Scotland	England	Wales	Northern Ireland	Isle of Man	Date of estimate	Unattached non-breeding birds	Medium-term trend (since 1970s) **[see Annex 4 for more detailed information]**	Short-term trend (1990s)
Golden eagle	Pairs	422[9]	421[9]	1[9]				1992[9]		Local declines consequent upon afforestation and illegal killing	Numbers and range stable 1982-1992
Osprey	Pairs	111[1]	111[1]					1997[1]		Slow population growth following re-colonisation in 1954	Continued population growth and recovery of range in Scotland
Kestrel	Pairs	51,500[7]	11,000[7]	35,500[7]	3,500[7]	1,500[7]	150[7]	1988-91[7]		Recovery during 1970s following earlier reduction of numbers in 1960s caused by organochlorine pesticides	Recent declines in range (NW Scotland). Significant (-18%) current decline in national numbers (1994-1998) detected by BBS[14]
Merlin	Pairs	1,300± 200[10,11,12]	602-994[10]	401[10]	80-90[10,11]	25-40[12]	Not regular	1993-94[10] 1993[11] 1992-95[12]		Recovery from low point 1950s-1980s as result of pesticide impacts and land-use change	Probably continued slow recovery and consolidation through 1990s
Hobby	Pairs	500-900[7]	1-6[6]	500-900[7]	6-20[1]			1997[1] 1994[6] 1988-91[7]		Increase in numbers and range northwards through England	Continued slow increase in numbers and range
Peregrine	Pairs	1283[13] (see comment re Isle of Man)	625[13]	283[13] (see comment re Isle of Man)	259[13]	96[13]	20[13] Note that territories of some IoM pairs also include parts of NW England	1991[13] See note **b** below for further expansion	Pre-breeding, an estimated additional *c.* 640 UK non-breeders, and post-breeding an additional *c.* 1,540 fledglings[18]	Recovery from major population crash in 1950s as result of pesticide impacts on breeding success	Recovery in numbers and consolidation of population range. Full recovery yet to occur in some areas (Annex 4). Actual declines in some parts of the Scottish Highlands.
Tawny owl	Pairs	20,000[7]	4,000[7]	14,000[7]	2,000[7]			1988-91[7]		11% decline and range contraction since 1968-1971[7]. 30% decline on CBC plots since 1970s, but poor coverage (BTO *in litt.*)	Annual trends unknown, possibly increasing in the uplands as a result of new afforestation[19]

References for Table 2.1

1 Ogilvie, MA & the Rare Breeding Birds Panel 1999b Rare breeding birds in the United Kingdom in 1997. *British Birds 92*: 389-428.

2 Shrubb, M 1998 *Welsh Bird Report, Vol. 2(2)*. Glamorgan, The Welsh Ornithological Society.

3 Sim, IMW, Gibbons, DW, Bainbridge, I & Mattingley, W 1999 *Status of the hen harrier* Circus cyaneus *in the UK and the Isle of Man in 1998*. Draft report to Raptor Working Group.

4 Petty, SJ 1996 History of the northern goshawk *Accipiter gentilis* in Britain. In: *The introduction and naturalisation of birds*, ed. by JS Holmes and JR Simons, 95-102. London, HMSO.

5 Shrubb, M. 1994. *Welsh Bird Report No. 7 1993*. Glamorgan, The Welsh Ornithological Society.

6 Ogilvie, MA & the Rare Breeding Birds Panel 1996 Rare breeding birds in the United Kingdom in 1994. *British Birds 89*: 387-417.

7 Gibbons, DW, Reid, JB & Chapman, RA 1993 *The new atlas of breeding birds in Britain and Ireland: 1988-1991*. London, T & AD Poyser.

8 Taylor, K, Hudson, R & Horne, G 1988 Buzzard breeding distribution and abundance in Britain and Northern Ireland in 1983. *Bird Study 35*: 109-118.

9 Green, RE 1996 The status of the golden eagle in Britain in 1992. *Bird Study 43*: 20-27.

10 Rebecca, G & Bainbridge, IP 1998 The breeding status of the merlin *Falco columbarius* in Britain in 1993-94. *Bird Study 45*: 172-187.

11 Williams, IT & Parr, S 1995 Breeding merlins *Falco columbarius* in Wales 1993. *Welsh Birds 1*: 14-20.

12 RSPB/Irish Raptor Study Group survey data.

13 Crick, HQP & Ratcliffe, DA 1995 The peregrine *Falco peregrinus* breeding population of the United Kingdom in 1991. *Bird Study 42*: 1-19.

14 Noble, DG, Bashford, RI, Marchant, JH, Baillie, SR & Gregory, RD 1999 *The Breeding Bird Survey – 1998*. Thetford, BTO/JNCC/RSPB, Thetford. 16 pp.

15 Newton, I, Wyllie, I & Dale, L 1999 Trends in the numbers and mortality patterns of sparrowhawks and kestrels in Britain, as revealed by carcass analyses. *Journal of Zoology 24*: 139-147.

16 Roberts, SJ, Lewis, JMS & Williams, IT 1999 Breeding European honey buzzards in Britain. *British Birds 92*: 326-345.

17 Newton, I 1986 *The sparrowhawk*. Poyser, Carlton.

18 Shawyer, C, Clarke, R & Dixon, N 1999 *A study into the raptor predation of domestic pigeons* Columba livia. Unpublished contract report from Hawk and Owl Trust to DETR and DoENI.

19 Petty, SJ 1992 *Ecology of the tawny owl* Strix aluco *in the spruce forests of Northumberland and Argyll*. PhD thesis, The Open University, Milton Keynes.

20 BTO *in litt.* National totals calculated from data in Gibbons *et al*. 1993.

Notes

a Buzzards. Results of monitoring at county scale have shown a continued recovery of buzzard populations with population recovery eastwards across England and Scotland. There has been no national survey since the 1988-1991 BTO breeding atlas, however, so it is not possible to assess precisely the size of the current population. These remain the best available population data at national scale. Trend information is monitored and there has been a 221% change in the annual Common Bird Census (CBC) index of abundance between 1972-1998, whilst the Breeding Bird Survey (which has a more even geographic spread of survey plots than does CBC) has recorded a 39% increase in the five years between 1994 and 1998.

b Peregrines. National surveys of peregrine populations in the UK are undertaken once a decade. The next national survey is programmed for 2001 (Table 2.5). The 1991 data presented are thus the results from the most recent comprehensive national survey. Surveys of more or less all occupied peregrine sites occur annually in some regions, however. These results allow at least for some areas an assessment of regional changes in numbers since 1991. The table below has been compiled by the Scottish Raptor Study Groups comparing regional patterns of territory occupancy in 1998 in regions surveyed as part of the national survey in 1991 and described by Crick & Ratcliffe (1995).

Table 2.1a
Changes in occupancy of peregrine territories 1991-1998. Data from the Scottish Raptor Study Groups.

Region or district	Territories checked in both 1991 & 1998			Total territories checked **(including those checked in both years)**			
	No. checked	Occupied 1991 (%)	Occupied 1998 (%)	Checked 1991	Occupied 1991 (%)	Checked 1998	Occupied 1998 (%)
South-west Scotland coastal	32	29 (91%)	29 (91%)	33	30 (91%)	37	33 (89%)
South-west Scotland inland	62	59 (95%)	42 (68%)	65	63 (97%)	101	68 (67%)
South-east Scotland coastal	5	3 (60%)	3 (60%)	6	4 (67%)	5	3 (60%)
South-east Scotland inland	31	31 (100%)	28 (90%)	31	31 (100%)	70	57 (81%)
Central & Tayside (south of R.Tay) inland	59	56 (95%)	47 (80%)	74	66 (89%)	63	50 (79%)
Tayside (north of R.Tay) inland	38	31 (82%)	29 (76%)	78	66 (85%)	69	53 (77%)
Tayside-Grampian coastal	13	12 (92%)	11 (85%)	17	14 (82%)	22	17 (77%)
Grampian inland	49	49 (100%)	38 (78%)	53	53 (100%)	89	56 (63%)

buzzard, red kite, white-tailed eagle, marsh harrier, Montagu's harrier and osprey), whilst a further six have populations of between 300-1,300 breeding pairs (hen harrier, goshawk, golden eagle, merlin, hobby and peregrine). Those species with populations of more than 1,300 pairs (Table 2.1) are buzzard (12-17,000 pairs), sparrowhawk (at most 34,500 pairs in the 1980s, Newton 1986) and kestrel (at most 51,500 pairs in the late 1980s).

Raptor numbers will not, of course, increase indefinitely as they are limited. In the absence of human interference, this limitation may be caused by food, nest site availability or perhaps through predation by other predators. Owing to past killing, most raptor species in the UK still appear to be below the level that contemporary habitat could support. Illegal killing remains a major factor, and in certain areas, limits the abundance and distribution of some species (principally red kite, hen harrier, goshawk, buzzard and golden eagle).

2.1.3 Legal status

Like other wild birds, all birds of prey are protected by the provisions of the Council Directive 79/409/EEC on the Conservation of Wild Birds. The Directive covers the protection, management and control of these species and lays down rules for their exploitation. Article 2 of the Directive requires Member States to 'maintain the population of the species referred to in Article 1 (*i.e.* wild birds) at a level which corresponds in particular to ecological, scientific and cultural requirements, while taking account of economic and recreational requirements, or to adapt the population of these species to that level.'

Article 3 of the Directive requires Member States to preserve, maintain or re-establish a sufficient diversity of habitats to meet the obligations in Article 2. In addition there are specific requirements in Article 4 (as amended by Council Directive 92/43/EEC on the conservation of natural habitats of wild fauna and flora) to establish Special Protection Areas (SPAs) for those species listed on Annex 1 of the Directive (which in this context includes honey buzzard, red kite, white-tailed eagle, marsh harrier, hen harrier, Montagu's harrier, golden eagle, osprey, merlin and

Table 2.2

Best-knowledge of historic population low-points of breeding population for birds of prey in Britain and proportions of potential range occupied. Information drawn from Holloway (1996) and Newton (1994).

Species	Population low point (with date)	% of potential UK breeding range occupied in early 1990s (Newton 1994)
Honey buzzard	Extinct (1900-1911)	Not known; probably <5%
Red Kite	Two successful pairs (1931-1935) in Wales; extinction in England and Scotland	5%
White-tailed eagle	Extinct (1916-1975)	<5%
Marsh harrier	Extinct (1898-1911)	10%
Hen harrier	50-60 pairs (c.1920-1940) restricted to Orkney only	60%
Montagu's harrier	Extinct (1974-1975)	Not known; probably <5%
Goshawk	Extinct (1883-1950)	15%
Sparrowhawk	0-50% regionally (1961-1963)	100%
Buzzard	Limited to western GB (1900-1930)	70%
Golden eagle	<100 pairs (c.1900-1914)	60%
Osprey	Extinct (1916-1954)	20%
Kestrel	Unknown (1960s)	100%
Merlin	550 pairs (1950-1985)	90%
Hobby	50-90 pairs (1900-1950)	Not known; probably 70%
Peregrine	c. 360 pairs (1963)	95%

peregrine) or are otherwise migratory (hobby). Within SPAs, Member States are obliged to take necessary steps to avoid deterioration of natural habitats and any disturbance of the species, where this disturbance would be significant having regard to the objectives of the Directive.

The UK statutory agencies are currently undertaking a comprehensive review of the requirements for SPAs for birds in the UK, and will be making proposals for a definitive suite of SPAs for birds of prey, including hen harrier. It is anticipated that this will add significant new sites to existing classified SPAs for hen harriers (such as Bowland Fells and the Rhinns of Islay). Within SPAs, management will seek to ensure the favourable conservation status of the species for which they have been classified and, to this end, a variety of financial mechanisms are likely to be available to assist the owners and occupiers of these sites.

Article 5 of the Directive sets out a general prohibition on the deliberate killing and keeping of birds or their eggs, and deliberate disturbance of birds particularly during the breeding and rearing season, providing this disturbance is significant in relation to the objectives of the Directive set out in Article 2. Article 6 prohibits the trade in wild birds, Article 7 sets out the rules for the hunting of certain species listed in Annex II to the Directive, and Article 8 prohibits the use of certain methods of killing birds.

Article 9 of the Directive permits derogations to be made from Articles 5, 6, 7 and 8 '*where there is no other satisfactory solution*,' for the following reasons:

- '*in the interests of public health and safety,*
- *in the interests of air safety,*
- *to prevent serious damage to crops, livestock, forests, fisheries and water,*
- *for the protection of flora and fauna,*
- *for the purposes of research and teaching, of re-population, of re-introduction and for the breeding necessary for these purposes,*
- *to permit, under strictly supervised conditions and on a selective basis, the capture, keeping or other judicious use of, certain birds in small numbers.*'

In the UK the provisions of the Wild Birds Directive are transposed by the Wildlife and Countryside Act 1981 for Great Britain, and the Wildlife (Northern Ireland) Order 1995 for Northern Ireland.

Section 1 of the 1981 Act prohibits the intentional killing of all birds, and the destruction of their eggs and their nests while they are in use or being built. Certain species listed on Schedule 1 to the 1981 Act, including honey buzzard, red kite, white-tailed eagle, marsh harrier, hen harrier, Montagu's harrier, goshawk, golden eagle, osprey, merlin and peregrine, are given enhanced protection (Table 2.3). It is an offence to disturb intentionally these species while they are building a nest, or are in, on or near a nest containing eggs or dependent young. In Northern Ireland, white-tailed eagle, marsh harrier, hen harrier, Montagu's harrier, goshawk, buzzard, sparrowhawk, golden eagle, osprey, kestrel, merlin and peregrine are given enhanced protection through their listing on Schedule 1 of the 1985 Wildlife (Northern Ireland) Order (Table 2.3).

The provisions of Article 9 of the Directive are transposed in Great Britain by Section 16(1) of the 1981 Act. Under this section a licensing authority can only issue a licence to take protected birds if that authority is satisfied that, as regards that purpose for which the licence is issued, there is no other satisfactory solution.

2.1.4 Conservation status

The conservation importance of raptors in Britain is reflected in the listing of 11 of the 16 breeding species as Red Data birds (Batten *et al*. 1990) (Table 2.3). Of these, six[1] are listed as of high conservation concern in the *Birds of Conservation Importance* and *Birds of Conservation Concern* evaluations published, respectively, by the UK statutory agencies and NGOs in 1996.

The UK is of particular international importance for sparrowhawk, kestrel and peregrine. Although the UK comprises only 2.3% of the continental European land surface (*i.e.* west of the Urals), it holds c. 10-20% of the total European population[2] of each of the above species. Particularly notable is the fact that the UK holds nearly a fifth (19.7%) of the peregrine population west of the Urals. The UK also has *c.* 7% of the European golden eagle population, over 4% of tawny owl, 3% of the merlin, and 1-2% of the red kite, hen harrier, buzzard, and osprey populations (Table 2.3). The red kite has a very limited global distribution, occurring only in Europe with a few pairs in North Africa (Evans & Pienkowski 1991).

The conservation status of European birds has been assessed by BirdLife International (Tucker & Heath 1994).

[1] Red kite, white-tailed eagle, marsh harrier, hen harrier, osprey and merlin.

[2] It should be noted that the data for bird population sizes in the UK are amongst the most accurate in Europe and, for many countries, population estimates are little more than informed guesses with wide error margins. This is particularly the case for Russia and some other eastern European countries. Thus expressing UK populations as a proportion of European totals arguably implies unfounded precision of knowledge.

The categories of the evaluation include whether a species has its world distribution centred in Europe and, as a separate factor, whether or not a species is in favourable conservation status in Europe. Ten UK raptor species are of conservation concern on a European scale (*i.e.* either of unfavourable conservation status in Europe, and/or have world populations concentrated in Europe: Table 2.3). Six of these – white-tailed eagle, hen harrier, golden eagle, osprey, kestrel and peregrine – have populations in unfavourable conservation status in Europe, whilst the other four – honey buzzard, red kite, Montagu's harrier and tawny owl – have their world populations concentrated in Europe (but are of favourable conservation status on this continent) (Tucker & Heath 1994).

2.2 Current and proposed monitoring provision for birds of prey in UK

There is a range of monitoring underway or planned to fulfil the requirements of the Wild Birds Directive. This is undertaken by different methods according to the current size of the species populations. Current monitoring provision for those species is summarised in Table 2.4.

2.2.1 Breeding Bird Survey and Common Bird Census

The annual monitoring of population trends, although not absolute numbers, in the three raptor species that are relatively abundant and widespread (sparrowhawk, buzzard and kestrel) is achieved through the long-running BTO/JNCC Common Bird Census (CBC; Marchant *et al*. 1990). Since 1994, the recently established BTO/JNCC/RSPB Breeding Bird Survey has extended the geographical scope of monitoring, and results from this scheme are reported annually (Gregory *et al*. 1997, 1998; Noble *et al*. 1999).

2.2.2 Rare Breeding Birds Panel (RBBP)

The RBBP currently collates data from a range of sources, including statutory licence returns to the country agencies and the Raptor Study Groups, and publishes a national summary report outlining annual breeding numbers of honey buzzard, red kite, white-tailed eagle, marsh harrier, Montagu's harrier, goshawk, osprey, and Hobby. With effect from the 1996 season, it has also published 'best available' summary data on breeding numbers of hen harrier, golden eagle, merlin and peregrine (Ogilvie *et al*. 1999a, b) although these do not provide complete national summaries or assessments.

Table 2.3

The conservation and legal status of birds of prey breeding in the UK.

Species	European population (Hagemeijer & Blair 1997) (in breeding pairs)	% European breeding population in UK	Conservation status		Legal status		
			Red Data Book	SPEC	Wildlife & Countryside Act 1981	Wildlife (Northern Ireland) Order 1985	EEC Wild Birds Directive
Honey buzzard	1128,090	<0.1	✔	4	Schedule 1	Does not breed	Annex 1
Red kite	21,784	1.1	✔	4	Schedule 1	Does not breed	Annex 1
White-tailed eagle	3,414	0.4	✔	3	Schedule 1	Schedule 1	Annex 1
Marsh harrier	60,820	0.2	✔		Schedule 1	Schedule 1	Annex 1
Hen harrier	26,712	2.1	✔	3	Schedule 1	Schedule 1	Annex 1
Montagu's harrier	42,564	<0.1	✔	4	Schedule 1	Does not breed	Annex 1
Goshawk	158,887	0.3	✔		Schedule 1	Schedule 1	Annex 1
Sparrowhawk	314,823	10.9				Schedule 1	
Buzzard	902,999	1.6				Schedule 1	
Golden eagle	5,695	7.4	✔	3	Schedule 1	Schedule 1	Annex 1
Osprey	7,939	1.4	✔	3	Schedule 1	Schedule 1	Annex 1
Kestrel	349,209	14.7		3		Schedule 1	
Merlin	42,166	3.1	✔		Schedule 1	Schedule 1	Annex 1
Hobby	73,857	0.9			Schedule 1	Does not breed	Article 4.2*
Peregrine	6,390	19.7	✔	3	Schedule 1	Schedule 1	Annex 1
Tawny owl	469,968	4.2		4			

European population

The European population estimates are taken from Hagemeijer & Blair (1997), and are the summed total for Europe and Russia (west of the Urals). The totals are spuriously precise since, to avoid multiple rounding errors and following normal practice, these totals are simply the sum of 41 separate national estimates, presented without rounding. The definition of Europe used includes the islands of the Azores, Madeira and the Canaries, Russia east to the Urals, and the Caucasus, but excludes the whole of Turkey. The proportion of the European population in the UK is calculated using the UK totals presented in Table 2.1. Note that the UK comprises 2.3% of the surface area of Europe thus defined.

Conservation status

✔ indicates that the species is listed as a Red Data Book bird in Britain by Batten *et al*. (1990).

SPEC are Species of Conservation Concern in Europe as listed by Tucker & Heath (1994).

3 indicates that the species is of unfavourable conservation status in Europe, but the world population is not concentrated in Europe;

4 indicates that the species is of favourable conservation status in Europe, and the world population is concentrated in Europe.

Legal status

Schedule 1 indicates that the species is listed on Schedule 1 of the 1981 Wildlife & Countryside Act in Great Britain, or the 1985 Wildlife (Northern Ireland) Order.

Annex 1 indicates that the species is listed on Annex 1 of the EEC Directive on the Conservation of Wild Birds (EC/79/409). Shaded squares indicate species not present.

* Hobby is not listed on Annex 1 but, since it is a migratory species, there are obligations under Article 4.2 to take special conservation measures for it.

RBBP essentially provides an annual means of national collation and dissemination of data collected by other parties. The completeness of its published summaries is dependent on the level of coverage achieved by individuals or organisations undertaking fieldwork. Coverage is thus known to be incomplete in most years for many raptors, especially those that are relatively abundant.

The honey buzzard's population size is probably the least accurately known of all British raptors (Roberts *et al*. 1999). This lack of submission of data to the Panel is because of the perceived sensitivity of this species to egg collecting and other human interference, although just how sensitive the species is to disturbance from nest visitation for simple recording purposes is a question of current debate (Roberts *et al*. 1999). The Panel is actively addressing the need to collate better information on the species with a suggested national survey in 2000 (RBBP 1999).

2.2.3 Single species surveys

A complementary programme of national surveys (the Statutory Conservation Agency/RSPB Annual Breeding Bird Scheme or SCARABBS) funded by RSPB and the statutory agencies, and with substantial additional inputs from the Raptor Study Groups, is planned to achieve comprehensive coverage of populations periodically. This will support the collation work undertaken by RBBP. There is an agreed schedule of surveys for red kite, marsh harrier, hen harrier, golden eagle, osprey, merlin and peregrine (Table 2.4). In 1998, a national survey was undertaken for hen harrier under this programme and supported by the Raptor Working Group (Sim *et al*. 1999).

2.2.4 Other survey and monitoring

The Working Group has further noted the initiative of the Scottish Raptor Study Groups and the Scottish Ornithologists' Club in publishing an annual summary of data (SOC & SRSG 1997, 1998). This is an important complement to other publications and summarises the extensive data collected each year by the Scottish Raptor Study Groups.

Since 1962, the Institute for Terrestrial Ecology (ITE) has monitored pesticide residues in carcasses of predatory birds found and submitted by the public. Newton *et al*. (1999) have recently used changes in annual rates of submission to infer changes in the regional and national abundance of sparrowhawk and kestrel populations (Annex 4). This is possible since the scheme has had a constant degree of advertising over the years.

Useful contributions of data relating to territory and breeding success from the UK are now being made to the European Raptor Monitoring Programme, co-ordinated by the University of Halle/Wittenberg, Germany.

2.3 Historical and current extent of killing

Some raptors have probably been killed at least since man began managing game and rearing livestock. During the period of medieval falconry, however, raptors were rigorously protected, with a death penalty in place for anyone found disturbing peregrine eyries.

The intensity of killing raptors (at that time legal) increased considerably from the start of the 19th century (especially following the emergence of the pin-fire cartridge in 1847, popularised at the Great Exhibition of 1851, when game shooting became fashionable). Before that time, the killing of raptors in the early part of the century was motivated in large part by desires to protect poultry (hence the name hen harrier) and other stock. Raptors were killed by gamekeepers (upland and lowland) as well as farmers (especially of sheep), to an extent that led to substantial population reductions and some UK extinctions (Gray 1871; Baxter & Rintoul 1953; Brown 1964; Newton 1979; Mearns & Mearns 1998).

As populations became rarer, they were particularly sought by egg and skin collectors, who further depleted them (Mearns & Mearns 1998). Without the introduction of legal protection, raptors would now be much rarer, and several more species would have almost certainly become extinct in the UK. Most raptor species are currently scarcer than at the start of the 19th century, and occupy only a part of their historic (Holloway 1996) and current potential range (Table 2.2; Annex 4).

It is difficult to assess the incidence of an illegal activity carried out covertly. Data on 'incidents' of illegal raptor killing reported give some indication of the likely extent and impact of this activity. Very few reported incidents result in prosecutions due to the inherent difficulty of securing sufficient evidence to bring such cases to court (RSPB 1995). Data on confirmed reported incidents[3] over the last 15 years give an indication of the occurrence of illegal raptor killing, including which species are most often involved, by which methods and by which interest groups. This is valuable in assessing the extent of the problem and in considering how to reduce it.

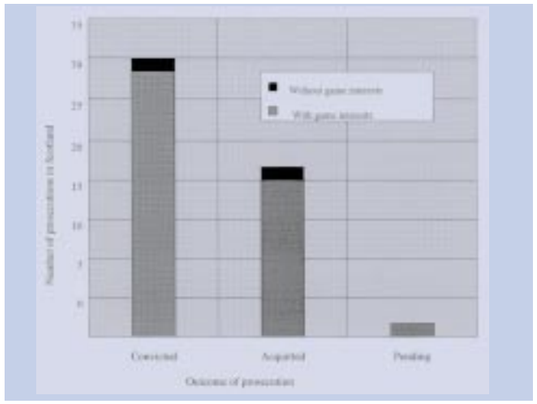
Although there have been many reports indicating the continuing extent of illegal killing (RSPB/NCC 1991; RSPB 1995, 1996, 1997; Annex 9), only scientific studies can reveal the impact of such killing at the level of populations (and thus may give an indication of the extent to which reported incidents reflect the true level of illegal killing). The most detailed studies of this sort include work by the RSPB on hen harriers (Etheridge *et al*. 1997), by RSPB/BTO and others on buzzards (Gibbons *et al*. 1995; Sim *et al*. in press) (following the earlier assessment by Moore 1957), as well as by the Scottish Raptor Study Groups (1998).

Recent compilation of data (Figure 2.1) on prosecutions taken in Scotland for illegal raptor killing or poisoning shows that the majority of cases are associated with game interests.

[3] A 'reported incident' is classified as a 'confirmed incident' when subsequent expert investigation of the evidence suggests that it involved the illegal destruction, by a deliberate human act, of adult raptors or the contents (eggs and young) of their nests.

Figure 2.1

Prosecutions known to RSPB in Scotland for poison and raptor killing related offences – 1985 to 1998, as at May 1999. Updated from Morton *et al*. 1998.



Notes

Those defined as 'with game interests' in this graph include: gamekeepers (87.8%); farmers who operate a shoot on their land (6.1%); and sporting managers (2.0%).Those defined as 'without game interests' were all farmers without a shoot (4.1%). Pending cases await a decision as to conviction or acquittal.

2.3.1 Most persecuted species

From 1990 to 1997, 720 confirmed incidents of the illegal killing of raptors (involving a minimum of 834 birds) were reported to the Agriculture Departments or RSPB. The buzzard is the species most often reported as killed, accounting for 40% of confirmed incidents in 1990-1997 (Table 2.6), and for half of the known birds illegally killed during 1979-1989. Peregrines and hen harriers are the next most frequently reported killed (19% and 14% of cases respectively). Kestrel and sparrowhawk each accounted for about 7% of the cases, with red kite, goshawk and golden eagle each accounting for 2-5%. These recorded cases and illegal egg collecting are likely to be particularly damaging to rare species such as red kite and osprey (Lovegrove *et al*. 1990; Bibby *et al*. 1990).

In relating numbers of reported incidents (Table 2.5) to population sizes (Table 2.1) it is clear that UK populations of hen harrier are potentially most affected by illegal killing, with the population of red kite also at high risk compared to its population size. There is also a high relative degree of illegal killing of the very small population of re-established white-tailed eagle as well as of peregrines.

The very rare Montagu's harrier is the only breeding raptor species for which there have been no reported incidents of illegal killing in the UK over the last 15 years.

Table 2.4

Summary of annual monitoring provision for at national (GB) level and desirable enhancements proposed by RWG.

Species	Last national survey	Next proposed national survey[4]	Scope of annual monitoring (fieldwork)	Annual reporting and dissemination procedures	Desirable enhancements recommended
Honey buzzard	1988-1991 BTO/SOC/IWC Breeding Atlas	National survey in 2000 proposed (RBBP 1999)	Some records submitted to RBBP, but known to provide an incomplete picture (RBBP 1999; Roberts *et al*. 1999)	Annual summary of data collated and published by RBBP (but dependent on coverage achieved by volunteers).	Better collation of existing data and information by RBBP, together with better survey co-ordination to ensure more complete coverage of the population is desirable.
Red kite	Annual	2000 (RSPB, RSGs, Welsh Kite Trust & statutory agencies)	Wales: effective complete annual census organised by Welsh Kite Trust	England and Scotland: effective national surveys each year through monitoring of re-established populations in S. and midland England and N. and C. Scotland (currently SNH, RSPB & EN, formerly also JNCC).	Annual summary data collated and published by RBBP.
White-tailed eagle	Annual	Annual	Scotland: effective national survey each year through monitoring of re-established population (currently RSPB & SNH with Raptor Study Group members).	Annual summary data collated and published by RBBP.	
Marsh harrier	1995	2005 (RSPB & statutory agencies)		Annual summary data collated and published by RBBP (but dependent on coverage achieved by volunteers).	
Hen harrier	1998	2008 (RSGs, statutory agencies, RSPB and others)	Considerable Raptor Study Group activity but not co-ordinated to achieve 100% coverage at UK level (probably 50-70% of hen harrier nests monitored annually).	From the 1996 breeding season, RBBP has collated and published an annual national total derived from Raptor Study Group monitoring, Schedule 1 licence holders (via country agencies) and County Bird Recorders.	National sample surveys at intervals of not more that five years should ideally be undertaken until such time as the population is in favourable conservation status.

[4] Organisations indicated are those likely to be organising and/or funding specified surveys.

Table 2.4 continued

[4] Organisations indicated are those likely to be organising and/or funding specified surveys.

Species	Last national survey	Next proposed national survey[4]	Scope of annual monitoring (fieldwork)	Annual reporting and dissemination procedures	Desirable enhancements recommended
Montagu's harrier	Effectively annual via RBBP	Next breeding atlas: 2008	Some records submitted to RBBP, but known to provide an incomplete picture (RBBP 1999; Roberts *et al*. 1999)	Annual summary of data collated and published by RBBP (but dependent on coverage achieved by volunteers).	Better collation of existing data and information by RBBP, together with better survey co-ordination to ensure more complete coverage of the population is desirable.
Goshawk	1988-1991 BTO/SOC/IWC Breeding Atlas	Next breeding atlas: 2008	Considerable Raptor Study Group activity but not co-ordinated to achieve 100% coverage at UK level. (See also Petty 1996.)	Annual summary data collated and published by RBBP (but dependent on coverage achieved by volunteers).	A sample survey to assess current national population numbers and distribution would be desirable.
Sparrowhawk	1988-1991 BTO/SOC/IWC Breeding Atlas	Next breeding atlas: 2008	Coverage on Common Bird Census plots has allowed calculation of national population index since 1974. BTO/JNCC/RSPB Breeding Bird Survey has covered since 1994 and will provide basis of monitoring in future.	CBC indices published annually by BTO. Annual BBS report published by BTO, JNCC and RSPB.	A sample survey to assess current national population numbers and distribution would be desirable.
Buzzard	1983 (BTO) 1988-1991 BTO/SOC/IWC Breeding Atlas	Next breeding atlas: 2008	Coverage on Common Bird Census plots has allowed calculation of national population index since 1977. BTO/JNCC/RSPB Breeding Bird Survey has covered since 1994 and will provide basis of monitoring in future.	CBC indices published annually by BTO. Annual BBS report published by BTO, JNCC and RSPB.	A sample survey to assess current national population numbers and distribution would be desirable.
Golden eagle	1992 (SRSGs, RSPB, SNH)	2002 (SRSGs, RSPB & SNH)	Considerable Raptor Study Group activity but not co-ordinated to achieve 100% coverage at UK level.	From the 1996 breeding season, RBBP has collated and published an annual national total derived from Raptor Study Group monitoring, Schedule 1 licence holders (via country agencies) and County Bird Recorders.	
Osprey	Currently effectively annual	2003 (SRSGs, statutory agencies & RSPB)	As national population size and range continues to increase, the quality of this coverage is expected to decline, leading to the need for a fully planned national survey in 2003.	Coverage of whole population is currently achieved by SRSGs and RSPB and others, with summary results collated and reported by SRSGs and RBBP.	
Kestrel	1988-1991 BTO/SOC/IWC Breeding Atlas	Next breeding atlas: 2008	Coverage on Common Bird Census plots has allowed calculation of national population index since 1965. BTO/JNCC/RSPB Breeding Bird Survey has covered since 1994 and will provide basis of monitoring in future.	Annual BBS report published by BTO, JNCC and RSPB.	Studies to investigate possible causes of recent, significant population decline (18% since 1994) would be valuable.
Merlin	1993-1994 (Rebecca & Bainbridge 1998)	2003 & 2004 (RSGs, RSPB & statutory agencies)	Considerable Raptor Study Group activity but not co-ordinated to achieve 100% coverage at UK level.	From the 1996 breeding season, RBBP has collated and published an annual national total derived from Raptor Study Group monitoring, Schedule 1 licence holders (via country agencies) and County Bird Recorders.	
Hobby	1988-1991 BTO/SOC/IWC Breeding Atlas	Next breeding atlas: 2008	Coverage on Common Bird Census plots has allowed, since 1965, calculation of a crude index of proportion of sites with Hobby presence (Marchant *et al*. 1990). BTO/JNCC/RSPB Breeding Bird Survey has covered since 1994 and may provide basis of monitoring in future but will be dependent on numbers of survey plots in southern England.	CBC indices published annually by BTO. Annual BBS report published by BTO, JNCC and RSPB. Annual summary data collated and published by RBBP (but dependent on coverage achieved by volunteers).	A sample survey to assess current national population numbers and distribution would be desirable.
Peregrine	1991 (BTO, JNCC, RSPB, RSGs)	2001 (RSGs, BTO, statutory agencies & RSPB)	Considerable Raptor Study Group activity but not co-ordinated to achieve 100% coverage at UK level.	From the 1996 breeding season, RBBP has collated and published an annual national total derived from Raptor Study Group monitoring, Schedule 1 licence holders (via country agencies) and County Bird Recorders.	Investigation of the causes of peregrine declines in parts of the Scottish Highlands would be highly desirable.
Tawny owl	1988-1991 BTO/SOC/IWC Breeding Atlas	Next breeding atlas: 2008	No annual population monitoring but coverage by the Nest Record Scheme, the BTO/JNCC/RSPB Breeding Bird Survey and on Common Bird Census plots (to be discontinued in 2001), as well as by the Ringing Scheme.	Annual BBS report published by BTO, JNCC and RSPB.	

Key to abbreviations

BBS Breeding Bird Survey
IWC Irish Wildbird Conservancy (now Birdwatch Ireland)
RBBP Rare Breeding Birds Panel
BTO British Trust for Ornithology
JNCC Joint Nature Conservation Committee
RSGs Raptor Study Groups
RSPB Royal Society for the Protection of Birds
SOC Scottish Ornithologists' Club
SRSGs Scottish Raptor Study Groups

2.3.2 Methods most frequently used in the destruction of raptors

Some raptors are killed deliberately using methods (such as shooting and destruction of nest contents) that target particular species or individuals. Other birds of prey are killed incidentally as a consequence of illegal control for 'pest' species such as crows and foxes – species that can otherwise be killed legally by different methods. This can result from the abuse of methods such as trapping. Some use of illegal poisons or traps is undertaken indiscriminately, and targeted at both legal pests and protected species alike. For example, analysis of reported incidents in Scotland in 1994 showed that the main methods used to destroy birds of prey illegally are destruction of nest contents, and shooting and poisoning (RSPB 1995). Trapping, illegally using crow cage traps (with live or dead bait) or spring traps (on poles or on the ground with a bait) also still occurs, but less commonly than the other three methods.

Carrion-feeding species (red kite, buzzard, and golden eagle) are particularly susceptible to methods involving poisoned bait. Poisoning was involved in all the red kite incidents during 1979-1989, and 87% of those in the following seven years. Over these two periods, poisoning accounted for a half to two-thirds of all buzzard and golden eagle incidents. By contrast, over the last seven years, poisoning has accounted for only about a quarter of the incidents involving goshawk, sparrowhawk, kestrel and peregrine (Table 2.5). These species, and especially the hen harrier, with only 7% of incidents involving poisoning, tend to be targeted more directly, particularly using shooting (sometimes by lamping at night) and nest destruction.

In the last seven years, 34% of confirmed incidents have involved illegal poisoning. In Scotland since the peak in 1989, there have been fewer reported poisoning incidents (RSPB

Table 2.5
Confirmed reported incidents of the illegal killing of birds of prey in the UK: incidents 1990-1997 (as at 15 September 1999). These are minimum estimates of the actual kill of all species.

Source: MAFF, Scottish Agricultural Science Agency Wildlife Incident Investigation Reports for poisoning; RSPB data for shooting, trapping & nest destruction. Note that there were no confirmed reported incidents involving Montagu's harrier. Species placed in rank order of impact of illegal killing relative to the size of the breeding populations. Minimum number of birds involved in the shooting, trapping & nest destruction category are considered to be understated, in particular for the 1990-1994 period.

UK 1990-1997	Poisoning		Shooting, trapping & nest destruction		Totals – all types of offence	
Species	No. incidents	Min. no. birds	No. incidents	Min. no. birds	Tot. incidents	Tot. min. no. birds
Hen harrier	7	8	95	123	102	131
Red kite	33	33	5	5	38	38
White-tailed eagle	1	1	1	1	2	2
Peregrine	21	23	113	134	134	157
Marsh harrier	2	4	2	2	3	6
Honey buzzard	0	0	1	1	1	1
Goshawk	2	2	15	16	17	18
Golden eagle	9	9	5	5	14	14
Buzzard	150	182	138	151	288	333
Merlin	0	0	10	12	10	12
Osprey	0	0	1	1	1	1
Sparrowhawk	12	12	42	46	54	58
Kestrel	5	6	47	54	52	60
Hobby	0	2	2	2	2	2
Rough-legged buzzard	0	0	1	1	1	1
TOTAL	242	280	478	554	720	834

1995, 1999a). This could reflect the influence of the government-led Campaign against Illegal Poisoning of Wildlife (section 2.3.5) and the legalisation of the Larsen trap which has encouraged the spread of the buzzard in the west Midlands – Sim *et al*. in press). However, since 1985 there has been a steady increase in the number of reported incidents of shooting, trapping and nest destruction to a peak of 117 in 1994 (RSPB 1995). These changes in numbers of confirmed incidents may simply reflect a change of behaviour by those undertaking illegal killing, from methods that are more likely to leave evidence (poisoning) to those where evidence can be rapidly removed (shooting). All of these changes should be seen against a background of heightened public awareness and probably an increase in reporting.

There have been significant changes in the types of poison used in illegal killing. There has been a marked recent increase in the use of carbamate insecticides such as Carbofuran (RSPB 1999a, b). From its first recorded use in 1988 it has, since 1997, become the single most widely abused pesticide.

Crow cage traps are widely used in the uplands and are subject to the provisions of an open General Licence. Continuing deaths of raptors and other non-target birds result from the abuse and misuse of crow cage traps (Dick & Stronach 1998, 1999). Such deaths are both unnecessary, and are likely to reduce public sympathy for the use of this legal method of pest control. In view of significant continued inadvertent as well as deliberate abuse, these provisions need to be reviewed to eliminate the capture of non-target species, including birds of prey. There are a number of actions that would make misuse or abuse less likely.

2.3.3 Do reported incidents reflect the true extent of illegal killing of raptors?

The data collected by the Scottish Raptor Study Groups (Annex 9) and others reveal a continuing high level of illegal killing of raptors. Other evidence indicates that recorded incidents reflect only a small proportion of the full extent of such killing that is taking place. The remote locations where much of this is happening, and the ease with which evidence can be hidden, inevitably mean that many incidents are not discovered.

2.3.4 Effects of illegal killing at the population scale

Illegal killing in the last century reduced the numbers of all species of birds of prey and the ranges of most, and led to the elimination of six species from the UK (see section 2.1.2).

The effects of illegal killing at the population scale have been demonstrated not only for hen harriers (below), but also for other raptors, including red kite, goshawk, buzzard, golden eagle and peregrine. Various population studies in the last 20 years[5] have reported a variety of population-level effects of illegal killing (reviewed by Newton 1979). For example, the relative impact of illegal killing, as compared to other factors limiting populations, has been examined for buzzard by Gibbons *et al*. (1995). In their analysis of reports of buzzard illegal killing from 1975-1989, Elliot & Avery (1991) considered that persecution was still a major factor restricting the range of buzzard in Britain. In part, this was indicated by the fact that buzzards were more likely to be reported dead through persecution at the edges of their range in Britain compared with the middle of the range. More recently, Sim *et al*. (in press) reported reduced levels of persecution in the west Midlands being responsible, in part, for an increase in buzzard numbers.

a) Hen harrier

Etheridge *et al*. (1997) have reviewed in detail the effects of illegal killing of hen harriers and their nest destruction in Scotland on their population dynamics. Breeding productivity, natal dispersal and survival were studied between 1988 and 1995 on moorland managed for sport shooting of red grouse, other heather moorland and young conifer forest in upland Scotland. They found, *inter alia*, that:

- *'Nest success was much lower on grouse moors than on other land management classes. Annual productivity was 0.8 fledglings/breeding female/year on grouse moors compared with 2.4 on other moorland and 1.4 in young conifer forests. Human interference was recorded on half the grouse moor estates studied and accounted for at least 30% of breeding failures in this land management class. It was much less frequent in the other land management classes.*
- *Annual survival of female hen harriers which bred on grouse moors was about half that of females breeding on other moorland. On grouse moors, survival of females* [hen harriers]*, which bred unsuccessfully, was much lower than that of females which reared at least one fledgling. Survival of breeding females on other moorland was high and unrelated to breeding success. The difference in survival of breeding females between grouse moors and other moors was attributed to killing by humans. On average 55-74 females were killed each year, 11-15% of the total population of breeding females in Scotland, excluding Orkney.*
- *The population of breeding females* [hen harriers] *on grouse moors was estimated to decline rapidly without*

[5] Sandeman (1957), Watson *et al*. (1989) and Watson (1997) for golden eagle; Moore (1957), Tubbs (1974) and Picozzi & Weir (1976) for buzzard; Ratcliffe (1993) for peregrine; Marquiss & Newton (1982) for goshawk; Davis & Newton (1981) for red kite; and Newton (1979) and Scottish Raptor Study Groups (1998) for several species. The latter includes evidence of effects at regional scale on golden eagle and peregrine in a number of areas of Scotland.

immigration. harriers breeding on other habitats were producing a surplus of female recruits approximately sufficient to compensate for the losses on grouse moors.

- *Moorland managed for grouse shooting was a sink habitat which received two-thirds of its female recruits from other habitats.*
- *The difference in productivity and survival between grouse moors and other habitats was attributed to illegal human interference.'*

Etheridge *et al*. (1997) speculated that without illegal killing by humans, the Scottish hen harrier population would increase initially by about 13% per year until a new equilibrium level was reached.

In England, Holmes *et al*. (2000) have reviewed the extent of illegal killing of birds of prey. They compared nesting success of hen harriers on moors managed commercially for red grouse with moors with discernible conservation interests (*e.g.* nature reserves or areas with nest protection schemes organised by the land owner/occupiers).

On English grouse moors without nest protection schemes, 61% of territorial female hen harriers attempted to nest, compared to 87% on protected moors. Only 44% of nesting attempts were successful on grouse moors compared with 85% on protected moors. Overall, of female hen harriers holding territory in England in spring, only 27% breed successfully on commercially managed grouse moors compared with 74% on protected moors. These are maximum success rates since some nesting attempts may have failed, and hence gone undetected. These figures are similar to the equivalent figures of 20% and 60% for grouse moors and other moors respectively, in Scotland (Etheridge *et al*. 1997).

Holmes *et al*. (2000) found that successful breeding of hen harriers in England is now restricted to 11 pairs in Northumberland, Geltsdale RSPB Reserve in Cumbria, and land managed by North West Water in the Forest of Bowland. Even here, where nests are closely monitored, the species does not escape illegal killing. They conclude that the hen harrier is close to extinction as a breeding species in England as a direct result of illegal killing.

As well as hen harriers, Holmes *et al*. (2000) consider red kite, peregrine and goshawk to be particularly vulnerable to illegal killing in England. Out of a re-established population of 579 red kites[6], 196 have been found dead in England between 1989 and 1998. Of these 196, an estimated 61 have been illegally killed.

b) Peregrine

The Scottish Raptor Study Groups (1998; Annex 9) found that in south-east Scotland human interference occurred at both lowland and upland peregrine breeding sites, but particularly at those on, or adjacent to, moorland managed for red grouse shooting. At lowland sites, recorded human interference involved the robbing of about a fifth of breeding attempts with an estimated loss of 19% of the potential production of young. At grouse moor sites, nest robbing, nest destruction and/or the killing of adults in about half of nesting attempts resulted in the loss of at least a third of the potential production of young. Taking into account the reduced occupancy of sites, the estimated loss on grouse moors was 52%. As a result, by the years 1994-1996 inclusive five grouse moor sites previously holding pairs on a regular basis had become deserted, or were occupied only sporadically by single birds. At other upland sites, human interference involved nest robbing in about a third of first nesting attempts but, as a result of re-nesting, the estimated final loss of productivity was 3%. In the whole study area, human interference was probably responsible for the loss of about 27% of potential production in the years 1990-1996. Subsequent survey by the Scottish Raptor Study Groups showed that in 1998, in south-east Scotland, of 13 instances of non-occupation of inland sites, 11 were attributed to killing by grouse moor interests, one to pigeon interests, and one to non-intentional disturbance, while in south-west Scotland at least 17 sites were unoccupied, associated with recent and apparently continuing illegal killing.

At nests in north-east Scotland, human interference was involved in failures at 8-22% of peregrine nesting attempts from 1981 to 1991, and has continued since. It was frequent on two estates, leading to the loss of about 74% of the production of young. On two other estates persecution was less frequently recorded, but was probably responsible for a loss of 12% in production. Persecution was unrecorded on three other estates. The overall loss of breeding production in the area as a whole that was attributable to persecution was at least 24%. No account could be taken of losses due to lowered occupancy, or reduced population recovery resulting from low production and the killing of full grown birds. Subsequent survey by the Scottish Raptor Study Groups showed that percentage occupation of grouse moor sites was at 69% in the years 1992 to 1994 inclusive, rose to 79% in 1995 but had declined to 55% by 1998. This decrease in occupancy rate has followed the more systematic killing that has occurred on grouse moors in recent years.

In central Scotland, each year a similar number of peregrine sites were checked on keepered and unkeepered ground. There was little difference in the pattern of occupancy of these sites, but a large difference in their productivity, those on keepered ground producing 38% fewer young than those on unkeepered ground. This was not because keepered ground was particularly poor in food (there was little difference in the fledged brood sizes there), but was due to the large number of breeding attempts that failed completely at six sites, suggesting routine interference with a third of peregrine pairs in keepered areas. In this case, human interference was affecting about a fifth of the peregrine breeding population in central Scotland, reducing overall production by about 18% from 1981 to 1996. Recent reduction in percentage occupation of a sample of central Scotland sites (from 95% in 1991 to 80% in 1998) was attributed by the Scottish Raptor Study Groups to decreases in food supply in certain western areas but to increases in illegal killing in some eastern parts of the region.

c) Golden eagles

In the Highlands, the Scottish Raptor Study Groups (1998; Annex 9) found circumstantial evidence of the effect of poisoning on the distribution of breeding golden eagles. Illegal poisoning in the northern half of Badenoch and Strathspey coincides closely with a conspicuous lack of breeding eagles in suitable habitat that has held nesting pairs in the past. A similar gap in golden eagle distribution occurs in east Sutherland where there have also been recent cases of poison abuse. It is likely that between ten and 20 golden eagle territories are affected.

In Tayside, the breeding performance of unmolested golden eagles in 15 territories was high. Performance was lower at three ranges due to egg robbing, and poorest at 14 ranges where other human interference (poisoning, trapping and shooting) occurred ,and at five ranges on moorland managed for red grouse. Based on breeding performance figures for unmolested ranges (0.42 young/range/annum in the west and 0.80 in the east) an average of 21.6 eaglets would have been expected to fledge in the Tayside ranges each year. Average production was 12.3, however, about 43% less.

In north-east Scotland, 21 golden eagle territories were monitored. Fifteen were on ground mainly managed for deer and were relatively successful (0.64 young/range/annum, 1990-1996). The remaining six were on ground managed for red grouse with some plantation forestry. These have poor production (0.26 young/range/annum, 1990-1996). Here there was intermittent occupancy by golden eagles in immature plumage, poisoning and nests destroyed, but at three ranges, illegal killing apparently ceased with pairs surviving to breed successfully. Assuming that all ranges could produce 0.64 young/range/annum, an average of 13.4 eaglets would have fledged each year from the 21 ranges in the area, but existing production of 11.2 eaglets was 17% less. Within the existing population there are also gaps where there is suitable habitat, suggesting that at least two more breeding pairs could exist if the population was unmolested.

In Argyll, the occupancy of golden eagle ranges was high and success reasonably good, but some persecution occurred. In south Argyll, over a 25-year period, up to three of 19 ranges suffered persecution in any one year. Had such human interference not taken place there would have been expected during this time 7% more successful breeding attempts (equivalent to 19 more eaglets fledged). This is a minimal figure as only known instances of persecution were used; suspected instances were not included, nor were those ranges where pairs have disappeared.

The results of the Scottish Raptor Study Groups (1998) clearly indicate wide-scale (regional) effects on the numbers, distribution and productivity of peregrines and golden eagles (as well as hen harriers) as a consequence of current patterns of illegal killing.

2.3.5 Government Campaign against Illegal Poisoning of Wildlife

Following an apparent increase in numbers of birds of prey illegally killed in the mid 1980s, and concern as to the effects of this killing on populations, the Nature Conservancy Council and RSPB jointly published in 1991 *Death by design* and *Persecution* – a twin summary of statistics and issues (RSPB & NCC 1991a, b). In the light of those reports, the government launched a formal UK Campaign against Illegal Poisoning of Wildlife. The campaign is co-ordinated by the Ministry of Agriculture, Fisheries and Food and involves a wide range of government departments, their agencies and Non-Governmental Organisations across the UK.

MAFF convenes six-monthly meetings of relevant government departments and other statutory bodies to co-ordinate actions, and an annual meeting of interested parties (government departments, police, non-governmental bodies *etc*.). These meetings are UK wide in their scope, although much of the focus is on England and Wales.

The campaign has focused on raising public awareness of the issues surrounding the use, misuse, and abuse of agricultural chemicals to poison wildlife. It has produced a range of publicity material aimed at educating the public and various target audiences (including game keepers, farmers, other land managers and the police). An important element has been to highlight legal means of pest control as well as to emphasise those that are illegal.

The Working Group considers that there is a need for enhanced support for this campaign (and against other methods of illegal raptor killing not currently tackled by the campaign). In particular, there would be considerable merit in a greater degree of promotion and co-ordination of campaign activities in Scotland. Such co-ordination already exists in England and another committee has recently been formed in Wales.

2.3.5.1 Scottish Office condemnation of bird of prey persecution

In September 1998, The Scottish Office published the results of the Scottish Raptor Study Groups' assessment of the extent of illegal killing of raptors in Scotland (Scottish

[6] The total number of red kites that have either been released or fledged from the newly re-established breeding population.

Raptor Study Groups 1998). The Scottish Office simultaneously published a booklet summarising these data (*Counting the cost. The continuing persecution of birds of prey in Scotland*). In this, Lord Sewel, Scottish Minister for Agriculture, the Environment and Fisheries stated that he regarded

> *'it as a national disgrace that illegal persecution is still taking place on such a scale and the government will take all steps within its power to reduce and eliminate it. We need to build on earlier initiatives* e.g. *the Campaign Against Illegal Poisoning which is aimed at raising public awareness of the problems caused by illegal poisoning. We are fully supportive of the excellent work by Police Wildlife Liaison Officers throughout the country to crack down on those involved. A poster campaign to draw attention to wildlife crime was launched last October by The Scottish Office and Scottish police forces. We are committed to strengthen protection for wildlife, and have indicated that we are generally sympathetic to recommendations from the Partnership for Action Against Wildlife Crime for changes to legislation to strengthen enforcement. It will be for the Scottish Parliament to take forward consideration of these proposals. I hope this report will be very widely read. Public opinion is a powerful force for change and I believe an increased awareness of the scale of the problem we face will play an important part in making it clear to those who commit wildlife crimes that their actions are indefensible and will not be tolerated.'*

In launching the report, Donald Dewar, then the Secretary of State for Scotland said that

> *'Although we are all aware of individual incidents of wildlife crime in Scotland, such as theft of eggs and shooting and poisoning of birds of prey, it is less well known that illegal persecution of some species, rather than the lack of suitable habitat, is the reason why in some areas the birds are scarce or non-existent. The government, and no doubt the Scottish Parliament will take all possible steps to eliminate persecution. The government is committed to strengthening protection for wildlife, and in due course the Scottish Parliament will consider proposals from the Partnership Against Wildlife Crime for stronger enforcement measures.'*

2.3.5.2 Recent poisoning of red kites

The Group requested and received a submission from the RSPB on the impact of poisoning of red kites in Scotland (Morton *et al.* 1998). This highlighted the serious levels of abuse of agricultural pesticides (notably Carbofuran) against birds of prey. The Group noted that the products most frequently abused in the uplands are not approved for use in these areas, but are generally those used on lowland arable crops.

The Working Group identified an inconsistency in the Control of Pesticides Regulations (CoPR 1996) which demand that individuals selling, storing for sale and (legally) using pesticides are trained and hold a certificate of competence. No similar requirement is made of those who simply possess pesticides. The Group recommends that the government should amend the 1996 CoPR to require those who possess pesticides to be licensed. The Working Group anticipates that such a change would have no adverse impact on farmers with a legitimate reason for possessing pesticides (since they will be already certified to use it), but that it would provide an additional enforcement tool to the police in that it would preclude the possession of such substances when there is no apparent reason for their legal use.

2.4 The contribution of birds of prey to local economies

Conservation related activity brings significant economic inputs to the rural economy in many parts of upland Britain. In recent years, there has been a major growth in this area of activity, and currently nature conservation supports employment and benefits local economies in different ways. For example:

- people are employed directly in conservation activities;
- expenditures by conservation organisations provide jobs for local suppliers and contractors;
- conservation schemes (such as agri-environment and woodland management initiatives) fund work in the wider countryside; and
- wildlife attracts visitors to rural areas, who spend money on local goods and services, helping to provide jobs and incomes for local people.

Direct employment

Direct employment in conservation has been estimated by CEAS Consultants (1993, for England and Wales) and MacKay Consultants (1997, for Scotland), who conducted surveys of organisations involved in conservation activities. These surveys indicate that there are more than 15,000 direct, full time equivalent (FTE) jobs in conservation activities in Great Britain (Table 2.6).

Employment in nature conservation is widely distributed across the UK, reflecting regional variations in natural landscape, habitats and biodiversity. Many of the jobs associated with conservation related activities are located in remote rural areas suffering from declining employment in agriculture and with a shortage of alternative job opportunities. In these areas, conservation plays an important role in promoting the diversification of the rural economy.

Table 2.6

Direct employment in conservation in Britain.

Country	Full-time equivalent jobs	Year	Source
England	7,666	1991-1992	CEAS Consultants (1993)
Wales	1,065	1991-1992	CEAS Consultants (1993)
Scotland	6,680	1996	MacKay Consultants (1997)
Great Britain	**15,411**		

Box 2.1 Economic impact of Abernethy RSPB Reserve.

The RSPB's Abernethy reserve was estimated to support 87 full time equivalent jobs in Badenoch and Strathspey in 1996: direct employment on the reserve totals 11 FTE jobs, with annual visitor spending attributable to the reserve and Osprey Centre totalling £1.7 million, supporting 69 FTE jobs; further jobs are sustained by expenditures by the reserve on contractors, goods and services, spending by reserve staff in the local economy, and the processing and marketing of reserve products such as timber and venison (Rayment 1997).

Employment in nature conservation is growing. For example, surveys indicate that employment in the natural environment sector in the Highlands and Islands more than doubled between 1987 and 1995 (Independent Northern Consultants 1995).

Conservation expenditures

In addition to direct employment, expenditures on other inputs also generate activity in the local economy and support employment for suppliers and contractors. In a survey of organisations involved in nature and landscape conservation, CEAS (1993) found that £384,000,000 was spent on conservation in England and £44,000,000 in Wales in 1991-1992. Heathland management in Dorset involves local annual expenditure of more than £1.2 million, providing 38 FTE jobs directly and an estimated 67 FTE jobs in total (Rayment 1997).

Spending by visitors

Spending by visitors to nature conservation sites often supports more jobs than those provided directly. For example, a survey of spending by non-Scottish visitors to 150 Scottish wildlife sites estimated that it supported 1,200 FTE jobs, compared to direct employment totalling 300 jobs at these sites (Crabtree *et al.* 1992). RSPB reserves in the UK bring extra visitor spending of at least £11,000,000 into local economies, supporting an estimated 320 FTE jobs in addition to direct employment of 200 FTE jobs.

Birds of prey and local economies

Surveys have demonstrated that birds of prey can bring significant benefits to local economies by attracting visitors to rural areas. For example:

- the Loch Garten osprey nest site attracts 40,000 visitors per year. A 1996 survey estimated that it brought extra tourism revenues of £1,700,000 to Badenoch and Strathspey, supporting 69 FTE jobs;
- 'Kite Country' visitor centres in Mid Wales attracted 150,000 visitors in 1996. A survey found that they brought extra tourism revenues of £2,900,000 to the area, supporting 114 FTE jobs, in addition to direct employment totalling 10 FTE jobs; and
- in the Forest of Dean, Gloucestershire, Symond's Yat Peregrine Falcon Viewpoint attracted 50,000 visitors in 1999. A visitor survey estimated that the peregrines brought extra annual tourism revenues of £550,000, supporting 20 FTE jobs.

2.5 Appraisal

Most birds of prey in the UK have now improved their population status compared to earlier this century. Illegal killing of most species continues however, despite statutory protection for over a century, at a level that, for certain species, constrains the recovery of their former distributions and population sizes (section 2.3.4). Just two of the 15 birds of prey occurring in the UK are distributed throughout their natural ranges (Table 2.2). All the rest are constrained to a greater or lesser degree. Indeed, in some cases, such impacts are very significant and, in England, the hen harrier is considered to be at risk of extinction (Holmes *et al.* 2000) with illegal killing of breeding birds occurring in 1999 on an RSPB reserve in northern England. There is strong inferential evidence of the direct impact of illegal killing on the distribution and numbers of golden eagles, peregrines, red kites and hen harriers in particular (Etheridge *et al.* 1997; Scottish Raptor Study Groups 1997, 1998; Morton *et al.* 1998; Holmes *et al.* 2000), whilst similar evidence for buzzards is presented by Moore (1957), Tubbs (1974), Picozzi & Weir (1976), Elliot & Avery (1991), and Gibbons *et al.* (1995). Sim *et al.* (in press) suggest that recent increases in buzzards in the east Midlands may be the result of reduced illegal poisoning.

Measures such as the government's Campaign against Illegal Poisoning of Wildlife have undoubtedly been helpful, but this campaign has probably been more effective in some parts of the UK than others. It only addresses illegal killing by abuse and misuse of poisons, and was not established to tackle the wider issues of the killing of protected species *per se*.

Evidence to the Group has stressed that the existing legislative status of birds of prey (under both national law and international treaties) is appropriate in scope and nature. Some aspects however, are difficult to enforce. This includes the detection of wildlife crimes and the provision of sufficient evidence to bring convictions. Indeed, a necessary first step towards restoring the natural ranges and population sizes of those species subject to widespread illegal killing is through the better enforcement of existing legislation. Enhanced enforcement is not only needed to reduce illegal killing *per se*, but also to underpin efforts to encourage game managers and others to pursue alternative, legal options of managing game stocks.

The government has conducted a public consultation on the proposals derived by the Partnership Against Wildlife Crime (PAW), and has recently indicated (section 2.3.5) that it is committed to strengthening protection for wildlife. It has indicated that, in due course, the Scottish Parliament in particular may consider proposals from the Partnership Against Wildlife Crime for stronger enforcement measures. We note changes to tighten the law, including stronger enforcement measures, as one important element of long-term solutions (section 7) which includes the need for management techniques to help moor managers within the existing legislative framework (section 3.2). The specific PAW recommendations are for other parts of government to take forward in their detail.

The question of issuing licenses to undertake commercial game shooting activities, as occurs in some countries (*e.g.* Spain) was raised and discussed by the Working Group, although no conclusions were reached.

The continued killing of birds of prey, in spite of legal protection, must be seen not just in terms of lack of law enforcement, but also as a result of the lack of solutions to the problems that game managers consider birds of prey present to them.

As well as stronger enforcement of existing legislation, other innovative policies may assist in changing attitudes and encourage the cessation of illegal killing. For example, future payments from biodiversity related incentive schemes for upland management should be conditional upon the effective protection of wildlife on the areas managed by the applicant. For example, should there be successful prosecution for illegal killing of protected wildlife, which had either been caused or knowingly permitted, this could debar future payments. Likewise, future involvement with upland incentive schemes linked to resolving bird of preyñgrouse conflicts, should be linked to access to bird of prey breeding sites by named individuals licensed by the competent authority for monitoring purposes in a spirit of partnership.

3 Birds of prey in the uplands and red grouse

3.1 The issues and context

There are a number of issues of concern to upland game managers. The extent of heather moorland managed for red grouse has declined significantly in most areas of the British uplands since the 1940s. As well as reductions in extent, there is also evidence that many of the areas that remain are managed sub-optimally. Additionally, some of those managing grouse moors have asserted that current levels of predation by hen harriers and other raptors have increased in the uplands in recent years, compared with former decades, such as to question the viability of driven grouse management. The issues are complex as will be the solutions.

We address the issues of habitats and hen harrier-red grouse interactions below. First, we summarise the current extent and nature of heather moorland, the reductions in extent and the causes of these. There is a range of issues resulting from the decline in habitat extent and quality of management.

We then turn to issues arising from predation of hen harriers and other birds of prey on red grouse, the extent to which these impacts may reduce significantly the autumn numbers of red grouse, and possible means by which these impacts may be reduced.

3.1.1 Heather moorland: extent and characteristics

Upland Britain extends to about 66,000 km^2 about 29% of the total land surface. Of this, about 46,000 km^2 has been estimated to be hill pasture, bog and moorland (20.8% of Britain) (Hudson 1992).

The Biodiversity Action Plan for upland heathlands (UK Biodiversity Group 1999; section 3.1.7) estimates that this habitat type is present on an estimated 270,000 ha in England, 80,000 ha in Wales, up to 69,500 ha in Northern Ireland, and between 1,700,000 and 2,500,000 ha in Scotland. The total extent of upland heath in the UK thus amounts to between 2.5 and 3 million hectares. (Note that these estimates exclude the extent of blanket bog, some of which in western Scotland is used as grouse moor.)

Upland heather moorland in north-west Europe is characterised by common heather *Calluna vulgaris*. These heather moors are found throughout the UK and Irish uplands (Figure 3.1). Although heather moorlands are also found in the extreme western and southern parts of Norway, and in limited areas elsewhere, on a world scale, it is predominantly a British biotope with an associated specialised fauna and flora. It is a habitat of high conservation value and now subject to a UK Biodiversity Habitat Action Plan (Thompson *et al*. 1995a, b, 1997). Most of these moors developed as a result of a phase of gradual deforestation, largely beginning with Neolithic farming, and ending with large-scale felling in the Second World War, with woodland regeneration prevented by burning and grazing. The shrubby cover of heather moors thus derives originally from a woodland ground flora. Upland heather moorland has considerable economic, nature conservation, landscape, archaeological, aesthetic and tourism-related value.

Not all heather moorland is the same, either in terms of botanical diversity or management (Figure 3.2). Thompson *et al*. (1995a) give distribution maps of heather moorland indicating the geographical variation in the distribution of component communities. There are broad ecological differences in the habitat, across the country, shaped mainly by climate, geology and topography.

Figure 3.1
Distribution of upland 10-km squares in Great Britain, contrasting those containing heather moorland that are managed predominantly for red grouse (filled circles) with heather moors which are managed for other land-uses (open squares) (From Thompson *et al*. 1997).

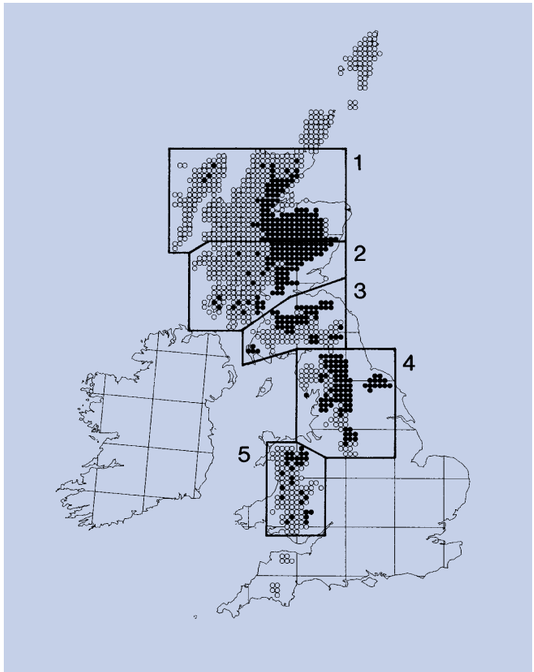


Figure 3.2

Diagram showing relationship between different upland habitat types. Note that the relative sizes of the boxes showing the different habitat types are not necessarily to scale since the exact extent of each of these habitats is imprecisely known.

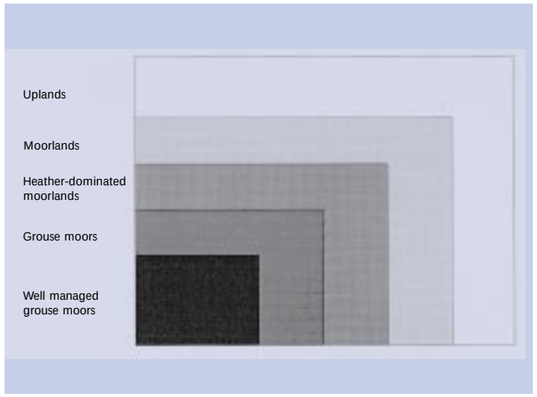
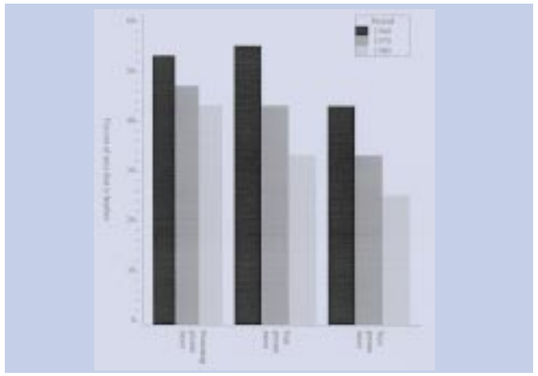


Figure 3.3

Amount of heather on Scottish upland estates where grouse shooting was retained between 1940 and 1980 (left columns; n = 57); moors where grouse shooting has ceased after 1940 (centre columns; n = 46); and moors where there has been no grouse shooting since at least 1925 (right columns; n = 126). Data from Barton & Robertson (1997).



Since around the beginning of the 19th century, some heather moorland has been managed for the production of red grouse, a sub-species of the widely distributed willow grouse; it is found nowhere else but Britain and Ireland. Today, grouse moors are generally located in the eastern part of Scotland, and parts of the English Pennines and Yorkshire Moors (Figure 3.1) (although formerly managed areas were more extensive and included some of the Welsh uplands; Lovat 1911). The main component of such habitat management is the regular burning of heather to form a mosaic of different aged stands, together with the appropriate control of grazing pressure on the heather. Control of predators is the other main grouse management activity. As a consequence of management for grouse, these moors have high capital values and revenue that helps to support the employment of gamekeepers.

Some grouse moors are better than others in terms of production of red grouse. Some grouse moors also hold a wide range of other fauna and flora (biodiversity). The extent to which patterns of upland biodiversity are caused by grouse moor management, or incidentally relate to similar features, is still an open question, and has been inadequately researched. Indeed, Brown & Stillman (1993) found that no other upland bird species exhibited similar habitat preferences to red grouse in the eastern Highlands of Scotland. Thompson *et al*. (1997) reviewed the importance of grouse moors for upland birds, and concluded that grouse moor management may not account for the differences found in many species' distributions. Several further analyses were suggested by Thompson *et al*. (1997) to try to identify the relevant factors determining these distributions.

Brown & Bainbridge (1995) also reviewed the extent to which grouse moor management was of value for birds other than grouse. They concluded that grouse moors have been instrumental in protecting uplands from land-use changes (*e.g.* conifer afforestation and agricultural intensification), but important populations of many upland species are found on moorlands managed for other purposes. Very few, if any, species are dependent on grouse moors *per se*. Moorlands managed for grouse may not necessarily have a high nature conservation value for other bird species. Whether or not grouse moor management directly results in the creation of habitats for other upland fauna or flora, there is broad consensus that, compared with other upland land-uses as currently practised – such as coniferous afforestation of open ground or sheep grazing – it is more benign in its impacts on internationally important components of biodiversity (Brown & Bainbridge 1995; Thompson *et al*. 1995a, 1997).

Moorland (including grouse moors) have a high species diversity of invertebrates (Usher & Thompson 1993). The principle areas of importance are wet flushes, open water or calcareous areas on moorlands, rather than the dry, dwarf shrub heath itself.

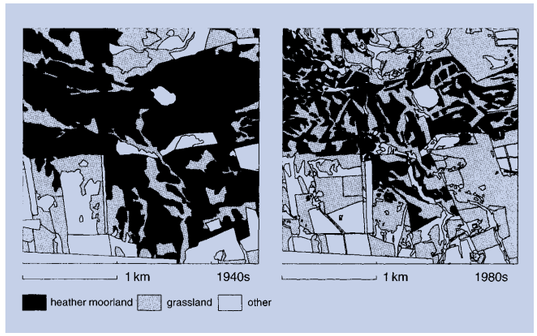
3.1.2 Losses of heather moorland

There have been long-term declines in the quality and quantity of heather moorland habitat. This is one of the principal reasons for declining driven grouse shooting activity at national level as documented by Barnes (1987). There are few good statistics on the extent of these declines. Interpretation of such statistics that do exist at UK or GB level is confounded by:

- the fact that most studies have not been national in extent (variously covering Scotland, England, Wales or England/Wales);
- the lack of consistent terminology and definitions of moorland, heather moorland, grouse moor and other habitat types (wet heath, dry heath, blanket bog *etc.*); and
- the adoption of a variety of periods within which change has been assessed.

Figure 3.4

Case study on the conversion of heather moorland to grassland, Tayside. From Mackey *et al*. 1998.



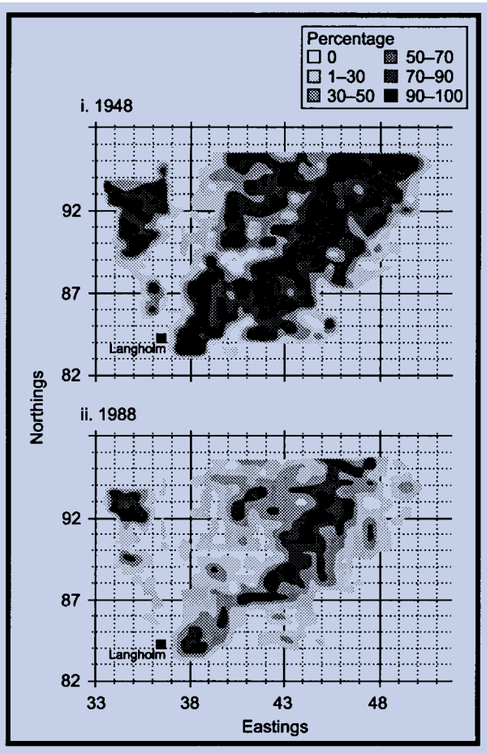
A Tayside sample square (2.5 x 2.5 km) from the National Countryside Monitoring Scheme provides an example of how relatively uniform stands of heather can become patchy and fragmented, and reduced in extent by pasture encroachment. With arable and pasture to the northern and southern margins of the case study, heather moorland was dominant in the 1940s square. Rough grassland was confined mainly to stream courses. The 1980s scene shows heather moorland reduced in area and patchy in distribution.

Heather moorland was reduced by farmland encroachment. Rough grassland expanded from the 1940s to the 1970s and was, in turn, converted to smooth grassland from the 1970s to 1980s. Patches of rough grassland within the remaining heather moorland appeared from the 1970s to the 1980s, as did bracken.

The net outcome in this case was the area of heather moorland, which had covered 54% of the square in the 1940s, was halved. Fragmentation also occurred, with the number of distinct vegetation patches increasing from 82 in the 1940s square (minimum mappable area 0.1 ha) to 407 in the 1980s.

Figure 3.5

Case study on the conversion of heather moorland to grassland, Borders. From Redpath & Thirgood 1997.



Changes in heather cover at Langholm from 1948 to 1988 as assessed from aerial photographs. Heather cover was estimated for 25 ha blocks and divided into five bands of abundance from 1-30% to 90-100%. Plots were drawn using a Minitab contour plot facility. The dotted lines indicate a 100 ha grid.

Both the extent and density of heather had been greatly reduced between 1948 and 1988. The number of 1 ha squares with heather-dominant vegetation (*i.e.* >50% cover) had declined by 48% over the 40 year period. In addition, the extent of heather loss was greatest at lower altitudes, being between 75-100% at lowest altitudes.

The decline in heather cover was consistent with the effects of heavy grazing, with the heather being replaced largely by grass-dominant swards, particularly at lower elevations.

Scotland

In Scotland, the National Countryside Monitoring Scheme (NCMS: Mackey *et al*. 1998) has derived detailed statistics on change in countryside features through comparison of aerial photographs from different periods. The data for heather moorlands in Scotland are summarised in Table 3.1 and Figure 3.7.

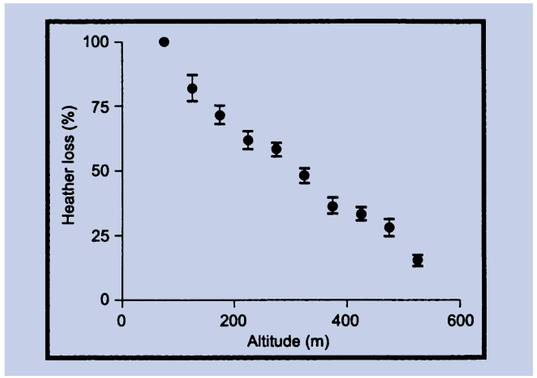
Between the 1940s and 1980s there was a net loss of 4,165 km^2 of heather moorland for the whole of Scotland (a 23% reduction in extent). Of this total, most was lost to coniferous afforestation (53%: 2,218 km^2), with substantial losses to rough grassland (33%: 1,111 km^2) caused by overgrazing, and to bracken (222 km^2) (Figure 3.6; Thompson *et al*. 1995a; Mackey *et al*. 1998). These overall figures may under-estimate the proportional loss of ground suitable for grouse, since most heather moorland losses will probably have been at lower altitudes (closest to former moorland edge) which will usually have been better quality areas for grouse, as has been shown by detailed studies at Langholm (Redpath & Thirgood 1997; Figure 3.6).

Barton & Robertson (1997) used historic photographic surveys of Scotland to calculate the amounts of heather lost from various upland estates (Figure 3.3). They showed that those properties maintaining an interest in grouse shooting also retained a much higher proportion of their upland area as heather compared to properties where there was no grouse interest or the sporting interest had been lost. They calculated that over 953 km^2 of heather in Scotland has been retained by grouse shooting interests which would otherwise have been lost.

Table 3.1 shows changes in the regional extent of heather moorland cover in Scotland. There were overall net losses of heather moorland in all regions of Scotland except for Shetland and the Western Isles. By area, losses were greatest in Highland (973 km^2), followed by Grampian (889 km^2),

Figure 3.6

Relationship between altitude and estimates of the (average) proportion of heather lost between 1948 and 1988 on 25 ha areas on Langholm moor, south-west Scotland. From Redpath & Thirgood 1997.



Tayside (626 km²), Borders (394 km²) and Dumfries and Galloway (361 km²).

England and Wales

Around 27% of upland heather moorland present in England and Wales in the mid 1940s has been lost to afforestation, agricultural land claim, high grazing pressure and bracken invasion. Of that remaining, 70% is estimated to be at risk of change, with at least 50% in 'poor' or 'suppressed' condition, liable to further reductions and damage from sheep grazing densities of greater than two ewes per hectare (Thompson *et al*. 1995a). Rates of loss locally can be very high. For example, an overall loss in heather cover of 66% occurred in the Derbyshire Peak District between 1940 and 1980 (Anderson & Yalden 1981).

As well as changes in extent there have also been changes in quality of heather moorland. In a recent survey of heather moorland in England and Wales, 47% of the total area of remaining moorland in England was judged in good condition (>50% heather cover), 29% was suppressed (<25% heather cover), while 24% showed obvious overgrazing or other management neglect. The equivalent figures for Wales, where most grouse shooting has stopped, were 19% in good condition, 43% suppressed and 38% overgrazed (Bardgett *et al*. 1995).

3.1.3 Causes of losses of heather moorland

Due to encouragement from production subsidies, sheep densities in much of the uplands have risen greatly in recent decades. Between 1950 and 1990 there was a 32% increase in upland sheep numbers in England, a 142% increase in Scotland (mostly in southern Scotland), and a 181% increase in Wales (Fuller & Gough 1999). Numbers have almost certainly increased since then. In Scotland, both numbers and distribution of red deer have increased, from *c*. 150,000 in the early 1960s to *c*. 300,000 in the early 1990s (SNH 1994). There has accordingly been a marked increase in grazing pressure throughout the uplands with consequences for quality and extent of heather cover.

The link between grazing pressure and loss of heather has been established from vegetation changes in particular areas following the introduction of sheep, and from correlations between vegetation and sheep densities in different areas (Anderson & Yalden 1981; Sydes & Miller 1988). The latter point is obvious at thousands of fencelines throughout upland Britain where grazing pressures from sheep have been higher on one side of the fence than on the other. In many areas, heather usually disappears first from the lower slopes, especially around winter feeding sites, and gradually recedes uphill (Figure 3.7).

Mean rates of loss have been calculated for a few areas from aerial photographs at around 1-4% per year. As a working figure, heather is said to persist with stocking densities up to 1.5 ewes per ha (Bardgett & Marsden 1992; Thompson *et al*. 1995a), and to decline under higher densities. However, heather is better able to resist grazing in some areas than in others (associated with soil wetness and other features), so the density of sheep likely to eliminate or reduce heather in a given time period varies somewhat from place to place. Loss of heather may also accelerate over time, for as overgrazing leads to spread of sheep resistant plants, such as bracken and coarse grasses, the sheep become progressively confined to feed on continually shrinking patches of edible plants, including heather. Providing heather has not been totally destroyed, these changes can be reversed by reducing grazing. Destruction of heather has been more marked in western areas than in eastern ones, and correspondingly, grouse have declined at the greatest rates in the west (Hudson 1992).

There is also concern that the large increases in deposition of fixed nitrogen from the atmosphere – derived from the burning of fossil fuels – may be having an adverse effect on the health of heather in the uplands. However, although these enhanced depositions are reflected in increased nitrogen content of heather shoots (Pitcairn *et al*. 1995), we are not aware that any adverse effects on heather cover have yet been demonstrated in Britain.

3.1.4 Grouse moors: extent and changes

3.1.4.1 Extent of grouse moors

There are no comprehensive statistics as to the exact extent or number of grouse moors. Such assessments as have been undertaken are based either on correlative methods related to other land-use statistics or extrapolations from sample surveys.

Table 3.1

Regional extent of heather moorland and changes in Scotland since 1940s. Data from the National Countryside Monitoring Scheme (Mackey *et al*. 1998).

Note

Note: The adjusted total removes the estimated area gained through the drainage of mires.
* = p < 0.05, ** = p < 0.01, *** = p < 0.001. The names of regions showing significant change (p < 0.5) are shown in italics.

Region	Land area of region (km²)	1940s (km²)	1970s (km²)	1980s (km²)	Net change 1940s-1980s (km²)	Proportional net change 1940s-1980s (km²)	Statistical significance
Borders	4,695	939	742	546	-394	-42%	**
Central	2,716	519	498	449	-71	-14%	*
Dumfries & Galloway	6,342	601	208	240	-361	-60%	*
Fife	1,377	15	5	5	-10	-66%	*
Grampian	8,686	2,536	1,809	1,647	-889	-33%	***
Highland	24,611	5,222	4,603	4,249	-973	-19%	**
Lothian	1,814	194	158	231	36	19%	
Strathclyde	14,430	1,832	132	169	-135	-7%	
Tayside	7,394	1,796	1,564	1,170	-626	-35%	**
Orkney Islands	1,115	94	80	64	-30	-32%	
Shetland Islands	1,810	405	370	474	69	17%	
Western Isles	2,847	462	464	525	63	14%	
Scotland	77,837	14,615	11,820	11,294	-3,321	-23%	***
Drained mire			192	839			
Adjusted total	14,615	11,628	10,455	-4,160	-28%		***

The ITE's Land Classification System – which covers the whole of the UK and was used in the Countryside Surveys of 1978, 1984 and 1990 (Bunce *et al*. 1992; Barr *et al*. 1993) – classifies 21 categories of upland cover. Three categories are characteristic of grouse moor management, and produce an estimate of 4,890 km² (being 28.9% of the total area of heather moorland and 6% of the total area of upland Britain) (Hudson 1992). According to this system, land classified as deer forest was estimated at 10,740 km² producing a total sporting area in the uplands of about 15,630 km (23% of upland Britain).

An independent assessment by Hudson (1992) obtained detailed information on land-use practice from 353 upland estates comprising 11,521 km². This information is based on incomplete coverage, although an estimate of total area was obtained by detailed mapping of upland estates producing an estimate of 746 estates and a total land area of 37,888 km². Hudson (1995) included land classified both as deer forest as well as grouse moor, but derived a total more than twice the estimate produced by the ITE Land Use Survey (Barr *et al*. 1993).

Excluding the regions of Scotland where deer stalking is the primary land-use, the estimated total number of grouse moors estimated by Hudson (1995) was 459 comprising 16,763 km². This is almost four times the area estimated by the ITE, but this difference probably reflects the different land classification definitions used by the two types of analysis.

GCT states that currently 55% of the total heather moorland area in Great Britain is managed for grouse. This represents 400-800 grouse moors; the definition of grouse moors is difficult, partly because it may include land that is sheep grazed and shot over only occasionally (Egdell 1995).

Since 1950, a total of 127 heather moors in Scotland, or 30% of the total, has ceased to be managed for significant sport shooting of red grouse, but only 50 have ceased in England and Wales.

We conclude that there are currently no definitive statistics relating to the precise extent of grouse moors at a national (GB or UK) level owing to the reasons summarised in section 3.1.2. Likewise, it is impossible to assess, at national level, changes in grouse moor extent with any degree of precision. Qualitative information and several regional studies all indicate a general decline in number of driven grouse moors.

Figure 3.7

Heather moorland net losses and gains in Scotland, 1940s to 1980s. From Mackey *et al*. 1998.

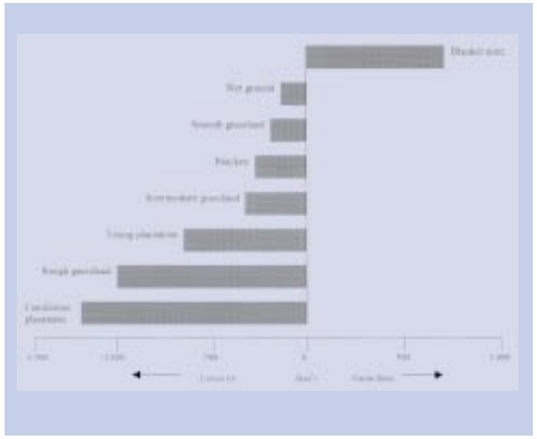
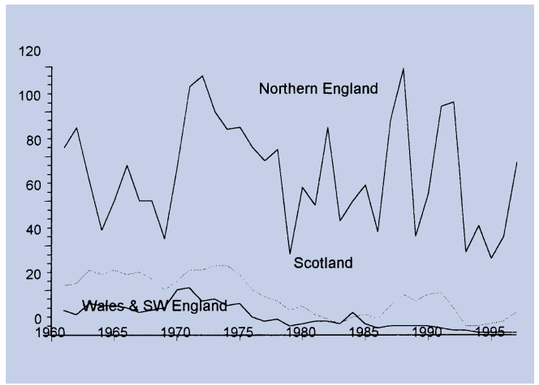


Figure 3.8

Changes in numbers of red grouse shot each year (mean bag/km^2) on managed estates in Scotland, Wales and England. Data from the National Game Census. These data minimise trends since the totals do not include those estates which no longer shoot red grouse. Data from the Game Conservancy Trust.



3.1.4.2 The sporting context: historical development of grouse shooting

The history of grouse shooting can be divided into roughly five periods:

1800-1850

During this period moors began to be burned to supply a productive food source for sheep, with the practice gradually being transferred from shepherds to gamekeepers as the importance of grouse relative to sheep grew. Progress was slow, however, and as late as 1836 there were only 608 gamekeepers in the whole of Scotland, most of them in the lowlands. (There were ten times as many in 1911.) Shooting of grouse was undertaken on a 'walked-up' basis using dogs, although following the 1830s the practice of driving over butts gradually became more common (Malcolm & Maxwell 1910). This did not become widespread until after the invention of the rapid-fire cartridge in 1848. Grouse driving became fashionable in England much earlier than it did in Scotland.

1850-1873

Development in guns at the beginning of this period made grouse driving an exciting sport, and this was the period of rapid development of grouse moor management, aided by the improved access to the uplands following the development of the railways.

1873-1910

This was a period of underlying stability, apart from cyclic fluctuations which is a characteristic of some grouse populations. Patch burning of heather developed to increase numbers and, at the same time, control disease. By the end of the period the value of grouse shooting in the UK exceeded £80 million per annum at present day values (GCT *in litt.*; Lovat 1911).

1910-1945

Grouse bags and grouse management were maintained during this period except for a substantial drop during the First World War. Bags quickly recovered after the war however, and were up to previous levels until the outbreak of the Second World War (Barnes 1987; Tapper 1992). Grouse bags and moor management virtually stopped during the war years, and it was at least two decades before the recovery was complete.

1945 onwards

Bags never regained their former pre-war levels in either Scotland or England. In England, on those areas where grouse moor management has been retained, bags on average have not declined. In Scotland there was an unprecedented decline which began during the mid 1970s, and numbers have only partially recovered since (Figure 3.8, Smith *et al*. 1999). In Wales and south-west England, grouse shooting and grouse moor management have almost entirely disappeared (Barnes 1987; Tapper 1992, 1999).

3.1.4.3 Determinants of red grouse abundance and productivity

Smith *et al*. (1999) have recently undertaken a major review of the factors important in determining red grouse abundance and productivity. They have showed that abundance and productivity was not related to heather cover on the heather-dominated sites studied. Data from additional sites where there was little heather cover, however, indicated that grouse densities are lower where heather is scarce. The location of study sites in England or Scotland, altitude and heather nutrient content explained 47% of the variation in spring grouse density. Grouse densities were highest on those sites that were in England, at low altitudes and had high heather phosphorous content. Grouse productivity was higher on sites with higher July temperatures, greater heather phosphorous content and more cotton grass.

Table 3.2

Best estimates of the status of the four grouse species that breed in the UK.

Sources

Population estimates all from Stone *et al*. (1997) other than for black grouse (Hancock *et al*. 1999) and capercaillie (Wilkinson *et al*. in prep.).

Quarry species	Best estimates of UK breeding population	Birds of conservation concern status (BoCC)	Criteria for BoCC status (from RSPB ***et al***. 1996)		
			> 50% decline in UK breeding population or range over previous 25 years	Historical population decline in the UK between 1800-1995	SPEC 2 & 3 status: unfavourable conservation status in Europe (see Table 2.3)
Red grouse	250,000 pairs	Green			
Ptarmigan	10,000 pairs	Green			
Black grouse	6,510 (lekking males) [95% confidence limits 5,200-7,600]	Red	✔	✔	✔
Capercaillie	*c.* 1,000 individuals	Red	✔		

Smith *et al*. (1999) found that within England, heather nutrient content explained more of the between-estate variation in red grouse density and productivity than the other factors they investigated. Within Scotland the density of gamekeepers, the presence of louping ill, and fox scat abundance, were the most important variables. The authors speculated that regional-scale benefits of high keeper density in England might account for some of the differences between England and Scotland. They found that red grouse densities were affected by heather cover when heather was scarce, but the nutrient content of the heather did explain some of the variation between study areas in grouse density and productivity. Predator abundance and parasite presence was also correlated with grouse density and productivity, but they stressed that the benefits of good habitat, predator and parasite control can only be assessed through experimental manipulation.

The way that moorland is managed can have an important bearing on predator density. The ratio of heather to grass, and the amount of heather burning, appeared important in determining meadow pipit abundance which was, in turn, correlated with hen harrier density (section 3.1.4.7). They found some evidence that grouse clutch and brood vulnerability was influenced by vegetation characteristics and thus by moorland management.

Overall, Smith *et al*. (1999) found that habitat may well influence the relationship between red grouse and their predators through effects of habitat on grouse numbers, effects of habitat on predator numbers, and effects of habitat on grouse vulnerability. They considered that experimental studies are now required to explore these issues further.

3.1.4.4 Declines in some red grouse populations

The current national population sizes and conservation status of four grouse species is summarised in Table 3.2.

Red grouse are confined to areas where heather is available. Hudson (1992) conducted an economic analysis of 361 grouse moors. Given the cost of keepers wages, and that driven grouse shooting has a market value per bird nearly three times the value of walked-up shooting, Hudson showed that only those moors which produced an average post-breeding density of >60 birds per km^2 were able to generate sufficient revenue to cover the costs of employing a gamekeeper. These densities can be achieved by good management of heather moorland, coupled with legal control of grouse predators, and in some areas active control of disease (Hudson 1992).

Declines have been investigated by the GCT in extensive research since the early 1970s, incorporating analysis of bag records going back into the earliest years of the 19th century (Hudson 1992). Overall the declines have been most severe in the west, including in Ireland, Wales and south-west England, and have been least in the eastern Pennines. In the southern Yorkshire Dales region, numbers have not declined. There are a number of significant differences between the situation in Scotland compared to that in England. Over the last 50 years Scottish, but not English grouse bags, have declined. In the last ten years, autumn grouse densities on monitored moors have not declined in either country.

There are several components to the factors causing declines where they have occurred:

1 The conversion of heather moorland to forestry plantation, which has reduced the area of habitat available, and fragmented that which remains. This accounts for about 50% of heather loss since the 1930s (Table 3.1).

2 The conversion of heather moorland to grassland as a result of increased grazing pressure from sheep (and in some areas from red deer) (section 3.1.2). Some areas of former heather moorland have been completely converted and are now unsuitable for red grouse, while many other areas are in various stages of conversion and therefore still support grouse, but in declining numbers.

3 A possible long-term decline in soil fertility that has been postulated to have resulted from burning and grazing regimes, with associated decline in the nutrient content of food plants. Although studies were undertaken in the 1950s and 1960s which indicated that this may be a significant issue (McVean & Ratcliffe 1962; Miller *et al*. 1970; McVean & Lockie 1969), further research is needed to determine the likely significance, with regard to the sustainability of moorland management practices, of such effects in the light of present-day knowledge of moorland ecology.

4 Loss of management for grouse has been demonstrated by a 85% drop in the number of moorland gamekeepers across an extensive area of Scotland since the turn of the century (1901-1981) with a more recent decline of 67% between 1951-1981 (Hudson 1992). On moors still managed for red grouse, gamekeeper numbers have remained approximately the same, but numbers of grouse declined in Scotland between 1975 and 1983. It has been suggested that weather or disease may have initiated the decline, but increased fox numbers, and subsequent predation on grouse, exacerbated the decline, and in many areas may have prevented grouse numbers from increasing (Hudson 1992).

5 Grouse on a small minority of moors (<10% in Scotland and England) are seriously affected by louping ill (Hudson 1986, 1992). This disease is transmitted by sheep ticks, and thus is most prevalent where there are high densities of sheep (thus exacerbating other habitat related issues consequent upon overgrazing by sheep). The presence of louping ill may render moors unsuitable for shooting (although this is slightly easier to manage in England where mountain hares and red deer, which act as additional, alternative hosts for ticks, are absent).

There also has been a general increase in the abundance of legally controllable predators during the last 50 years, notably foxes and crows (Smith *et al*. 1999). Such increases have not necessarily occurred at the same rate throughout, however, or in all areas. The evidence for increases in the densities of foxes and crows stems partly from increased numbers killed by individual gamekeepers (expected if fewer areas were keepered) or per unit area of keepered ground (Hudson 1992; Reynolds & Tapper 1994) and other studies such as the results of Common Birds Census (CBC) monitoring (Gregory & Marchant 1996).

3.1.4.5 The problem: raptor predation impacts on red grouse

Those managing grouse moors have asserted that current levels of predation by hen harriers and other birds of prey, the distributions of which have recovered in the uplands compared to former decades, are such as to call into question the viability of driven grouse management.

Can predators limit red grouse populations?

The role of predation in limiting bird populations is still controversial, and few studies have clearly demonstrated experimentally that predators can reduce population density or breeding success. In a recent review, Newton (1998) concluded that two groups of ground-nesting birds – waterfowl and gamebirds – were particularly prone to limitation by predation. Amongst the gamebirds, only for black grouse, capercaillie and grey partridge have two predator removal experiments demonstrated that increased breeding densities and/or success may result (Marcström *et al*. 1988; Tapper *et al*. 1996).

One factor contributing to uncertainty over predator limitation in birds is that it is not straightforward to study predation in wild populations. The numbers of many bird species can more than double each year through breeding, so that if their population is to remain stable, more than half the population must die each year. For predators to limit a bird population, at least part of the mortality they inflict must be additive to other mortality, and not simply compensatory, that is, replacing other forms of death.

Whether losses from predation are subsequently offset by improved reproduction or survival among remaining birds depends on whether these aspects vary in a density dependent manner. The important point is that predation does not necessarily have the impact on the overall breeding population levels that would be expected simply from the numbers of individuals killed (Newton 1993, 1998).

The distinction between breeding densities in spring, and postbreeding densities of birds in autumn, is also important, and partially explains why there has been some confusion between ecologists and game managers over the role of predation in limiting bird numbers. Ecologists attach primary importance to breeding numbers, whilst game managers are more concerned with producing large postbreeding numbers of birds for harvest. It is not contradictory that predation might reduce the post-breeding peak in numbers, but have little or no impact on the pre-breeding low (Newton 1993, 1998). This is a particularly important observation in relation to the current discussion.

Recent concerns surrounding the possible limiting effects of predators on red grouse populations centre on the importance or otherwise of raptors. It is important, therefore, to explain that this concern relates to situations that have arisen where, already, the impact of crows, foxes

and, to a lesser extent, stoats might have been legally reduced to a minimum. In practice, it is not clear how many moors actually achieve this type of controlled situation. Because of experimental work on other gamebirds (Marcström *et al*. 1988; Tapper *et al*. 1996), the benefit to moor owners of legally controlling foxes and crows, in particular, is generally accepted, although it has yet to be quantified precisely through experiment on red grouse populations.

There have been a number of studies on the effects of predators on red grouse populations. The first was on a high-density moor in northeast Scotland during 1957-1962, a period when raptor and fox densities were generally low (Jenkins *et al*. 1963, 1964; Hewson 1984; Watson 1985). In this area, grouse took up territories in autumn, but their density was limited by territorial behaviour, leading to exclusion of nonterritorial grouse. Predators concentrated on nonterritorial grouse, as opposed to territory owners, and predation appeared unimportant in limiting either the numbers of breeding grouse, or the numbers available for shooting. These areas, however, were subject to continuous predator control by gamekeepers during the course of the study.

The second study focused on a low-density grouse population on a moor in the central Highlands of Scotland during 1985-1990, a period when predators, mainly peregrines and foxes, were at relatively high density (Hudson 1992). In this area, overwinter survival rates of territorial and nonterritorial grouse were similar. Since suitable parts of the moor were unoccupied in spring, it was suggested that at least part of the winter predation was additive and reduced the density of breeding birds in spring.

These two studies can be reconciled if it is assumed that they applied to red grouse populations at different levels with respect to the carrying capacity of the habitat, and that on both areas predator numbers were reduced by gamekeepers. If post-breeding numbers were high relative to carrying capacity, predation might merely remove part of the surplus without reducing breeding density. If post-breeding numbers were low, the same level of predation might cut into the breeding stock.

The importance of the relative densities of grouse and their predators has also been highlighted in two studies of predation by hen harriers on red grouse chicks. Picozzi (1978) estimated that hen harriers removed only 7.4% of grouse chicks from a moor with a high density of grouse (>40 female grouse per km^2), whilst Redpath (1991) suggested that grouse at lower densities (<10 female grouse per km^2) were likely to experience higher levels of predation. Redpath went on to demonstrate at a small sample of study sites that hen harriers could account for most of the grouse chick mortality after the first two weeks of age. Comparisons between matched pairs of moors demonstrated that moors with hen harriers produced 17% fewer grouse chicks than moors without hen harriers. This did not, however, prove any causal link between hen harriers and grouse production.

3.1.4.6 Birds of prey and red grouse – the Joint Raptor Study including recent changes at Langholm (1997-1999)

The studies described above suggested that the relative abundance of raptors and grouse could be a key factor determining the importance of any raptor predation impact on limiting red grouse populations. Little information was available, however, on the mechanisms involved, or on the factors influencing raptor numbers and diet on grouse moors. With this in mind, a study was established in 1992 by the Institute of Terrestrial Ecology and the Game Conservancy Trust – two organisations with long involvement in research on raptors and grouse. The study was funded and guided by a consortium of interest groups that included the Buccleuch Estates, the Joint Nature Conservation Committee, the RSPB, the Game Conservancy Scottish Research Trust, Scottish Natural Heritage, and a private landowner, Peter Buckley of Westerhall Estate (Redpath & Thirgood 1997).

The purpose of the Joint Raptor Study was thus summarised: 'The main objective of this study was to find whether raptor predation could limit red grouse numbers at a level substantially lower than would occur in the absence of raptors. The associated applied question was: is it possible to run an economically viable grouse moor and allow raptors to breed freely?' (Redpath & Thirgood 1997).

The study was conducted in the main at Langholm in southern Scotland. Langholm was historically one of Scotland's finest moors, and held the record bag of 2,523 grouse shot in a single day in 1911. In common with many Scottish moors, grouse bags at Langholm had declined this century at approximately 2% per annum. This decline was

Figure 3.9

Numbers of known breeding hen harriers and peregrines on Langholm moor, Scotland. Also shown is the period covered by the Joint Raptor Study, and the years (1995 & 1996) for which the impact of these raptors on red grouse was estimated. Peregrine numbers were not known before 1993.

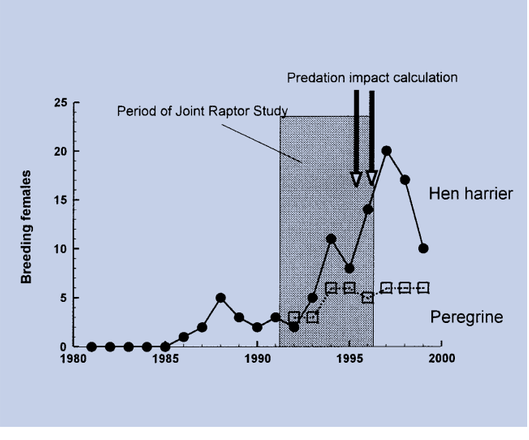
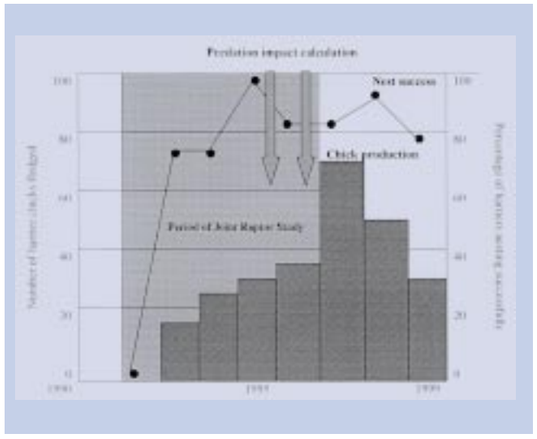


Figure 3.10

Numbers of known hen harrier chicks fledged on Langholm moor (bars) and the percentage of female harriers that nested successfully. Also shown is the period covered by the Joint Raptor Study, and the years (1995 & 1996) for which the impact of these raptors on red grouse was estimated.

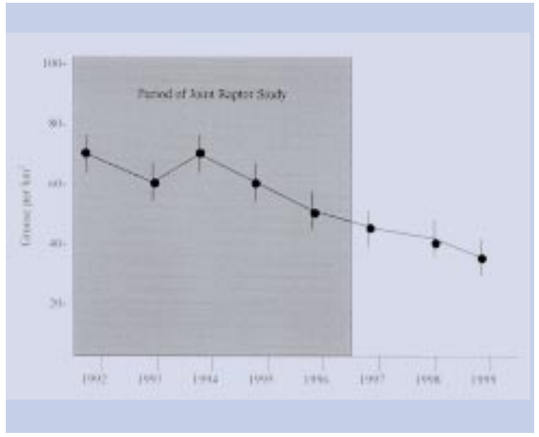


not due to raptor predation, as raptors were uncommon before 1990. It is associated with the loss of heather habitat, which provides both food and shelter for grouse, and with possible increases in other predators such as crows and foxes. Comparison of aerial photographs taken at Langholm during 1948 and 1988 indicated that heather cover declined by 48% in this period (Figures 3.5 & 3.6). Thus a finding of the study was that raptors were not the cause of long-term grouse declines at Langholm and, by extension, were probably not implicated in long-term declines in grouse as had been suggested by others.

Numbers of breeding female hen harriers at Langholm increased from two in 1992, to 20 in 1997, and fell back to 11 in 1999 (Figure 3.8). These densities were amongst the highest recorded on the Scottish mainland. Peregrine numbers increased also from three to five or six pairs. In each of 1995 and 1996, raptor predation in spring removed on average 30% of the potential breeding stock of grouse, and in the summers of 1995 and 1996 hen harrier predation removed on average 37% of grouse chicks. Most of these adult and chick losses were probably additive to other forms of mortality, and together reduced the post-breeding numbers of grouse by an estimated 50% within a single breeding season. In each year, raptors also killed on average 30% of the grouse between October and March, but it was not possible to determine what proportion of these grouse would have survived in the absence of raptors. A simple, mathematical model of the grouse population at Langholm, combining the estimated reduction in breeding productivity with observed density dependence in winter loss, predicted that over two years, in the absence of breeding raptors, grouse breeding numbers would have increased by 1.3 times and post-breeding numbers would have increased by 2.5 times.

Figure 3.11

Density of red grouse from sample areas on Langholm moor in April (the breeding population). There is an overall significant downward trend. The period of the Joint Raptor Study is shown.



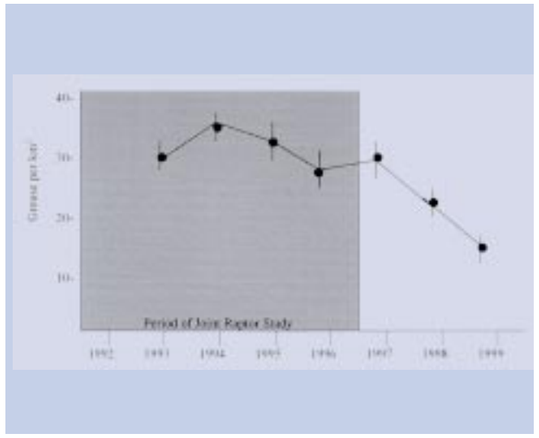
Although spring densities of grouse did not change significantly during the course of the study, they would have been expected to increase, as other neighbouring moors appear to have done, and as predicted by the model above. Further, these estimates of hen harrier impact clearly did not represent the maximum extent of this predation as in 1997 66 young hen harriers were reared at Langholm compared to an average of 32 in 1995 and 1996 (Figure 3.9; Thirgood & Redpath 1999). Overall, red grouse breeding densities, as well as post breeding densities, have shown significant declines below the 1994 level (Thirgood & Redpath 1999; Figures 3.10 & 3.11). The role of raptors is unknown in current declines.

Analysis of bag records demonstrated that, in common with many grouse moors, grouse bags at Langholm fluctuated with approximately a six-year cyclic pattern (Figure 3.13). The last peak year at Langholm was in 1990, when more than 4,000 grouse were shot, and the next peak was expected in 1996. Grouse bags declined year on year from 1990 until 1997 to a level where driven grouse shooting became untenable. This decline coincided with the increase in the numbers of hen harriers and peregrines breeding on the moor. A model based on the Langholm grouse bags from 1950-1990 suggested that the observed bags in 1995 and 1996 were much lower than expected. The model prediction, that Langholm grouse bags should have increased to a cyclic peak, was supported by the increased bags on two nearby grouse moors which formerly cycled in synchrony with Langholm. The most obvious difference between Langholm and the nearby moors was that Langholm had high densities of hen harriers and peregrines, while the other moors had low densities of these raptors.

If raptor predation could limit the grouse population at Langholm at low density, would this also happen on other

Figure 3.12

Density of red grouse from sample areas on Langholm moor in July (post breeding and before the shooting season. There is an overall significant downward trend. The period of the Joint Raptor Study is shown.



moors in the absence of the illegal killing of raptors? To answer this question we need to understand both the numerical[1] and functional responses[2] of hen harriers and peregrines in relation to red grouse. Hen harrier and peregrine breeding densities were not primarily related to the densities of grouse.

The highest breeding densities of hen harriers occurred on moors where meadow pipits and field voles were most abundant. These prey appeared to prefer moors where there was a mosaic of heather and grass. Such high densities of hen harriers might not be expected on moors with more continuous heather cover. Where sheep grazing turns heather to grass-heather mixes, it indirectly favours hen harriers by creating habitat suitable for meadow pipits and voles, as well as providing nesting areas for hen harriers. On other moors, where hen harriers occur at much lower densities, their numbers are compatible with driven grouse shooting. For example, on Moor C, another moor in the Joint Raptor Study, in 1996-1998, low densities of hen harriers (not subject to illegal killing at the time of study) coincided with high driven grouse bags.

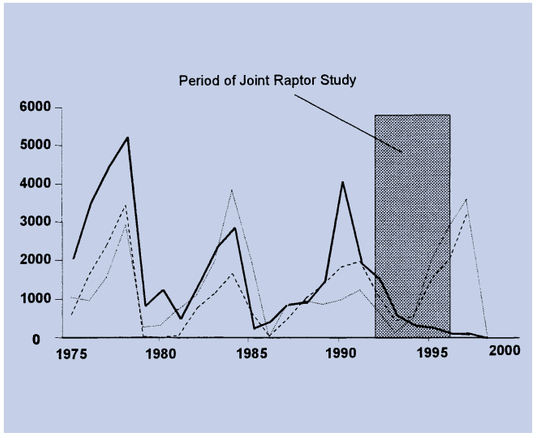
Peregrine breeding densities increased at Langholm. Ratcliffe (1993) had earlier suggested, and Redpath & Thirgood (1997) demonstrated, that peregrines were more widely spaced in the north because of a reduced abundance of racing pigeons. It thus seems that, in the absence of illegal killing, hen harriers and peregrines would breed at high densities on southern rather than northern moors, and on moors with a high ratio of grass to heather.

[1] The numerical response is the way in which the number of predators on an area changes with prey density.

[2] The functional response is the way in which the number of prey killed per predator changes with prey density.

Figure 3.13

Red grouse bags (individuals) at Langholm (solid line) since the mid 1970s compared with two neighbouring moors. Notice that all three showed similar cyclic variation until the mid 1990s when Langholm bags failed to show the expected increase and cyclic high. The period of the Joint Raptor Study is shown.



Hen harriers and peregrines eat a variety of prey species. During the summer on grouse moors, meadow pipits (and several other birds), voles and grouse are the main prey of hen harriers, and pigeons and grouse the main prey of peregrines. Whilst grouse are not numerically the most important prey for either species, the way in which the proportion of grouse increases in the diet of hen harriers and peregrines has important implications for the impact of predation on the grouse population. The importance of grouse in the summer diet of peregrines also increased in relation to grouse density, but the relationship was different with the greatest proportion of grouse removed by individual peregrines at grouse densities below 10 pairs km^2. The implication of these relationships is that, for any given number of hen harriers or peregrines, the impact of predation is likely to be greatest on relatively low density grouse populations.

To summarise, the 1992-1996 research at Langholm demonstrated that, whilst raptors were unlikely to have been responsible for the long-term declines in grouse bags this century, they were capable of limiting grouse populations at already low density, and of reducing shooting bags. Impact on grouse populations through raptor predation is most likely to occur where raptors breed at high density in response to high densities of alternative prey, especially meadow pipits and voles. The impact of raptor predation will be most severe where grouse populations are at low density, either because of poor habitat or other management, or during the regular troughs in abundance in cyclic populations.

Since 1996, the last year reported on in the Joint Raptor Study, hen harrier numbers have declined from a peak of 21 pairs in 1997 to 11 pairs in 1999. Red grouse densities in

spring and autumn have continued to decline, and Langholm Estate has decided to suspend driven grouse shooting on the moor.

3.1.4.7 Meadow pipits and hen harriers

Meadow pipits and voles are found in high densities on grass-dominated moorland where they form an important food for hen harriers. In their studies at Langholm, Redpath & Thirgood (1997) found that the highest breeding densities of hen harriers occurred where meadow pipits and voles were most abundant. Indeed, they occurred most on moors with a high grass/heather ratio.

More recently, in their more extensive study Smith *et al*. (1999) investigated passerine abundance at 36 1-km^2 sites throughout Britain. Across moors, meadow pipit abundance was greatest where there was least heather and least active heather management. No relationship was found between meadow pipit and red grouse abundance either within Langholm or between other study moorlands.

Smith *et al*. (1999) noted that, as hen harrier breeding density is related to meadow pipit abundance, altering the ratio of heather to grass on a moor may alter meadow pipit numbers, and thus the ratio of hen harriers to red grouse. They considered that such habitat changes (increasing heather cover at the expense of grass) might therefore provide a long-term solution to minimising hen harrierñred grouse conflicts.

3.1.5 Economics of grouse moor management

The capital value of a grouse moor is determined almost entirely by the grouse bags obtained over a period of years. This capital value helps justify the annual investment in management, a large part of which – often in excess of 80% of the total costs – is in the employment of the gamekeeper.

Therefore, grouse density is fundamental to the economics of grouse shooting and, in determining this density, the density of breeding stocks and their production are equally important. There are two modes of grouse management for any given amount of quantity and quality of heather:

1 Little or no management, no full-time gamekeeper employed. Dogs are used to aid walked-up shooting – occasionally falconry can be used also. Numbers of huntable grouse are low, as is grouse density. There is little investment in moor management.

2 Intensive management with full-time gamekeepers employed. Shooting is by driving with beaters and about 30% of the autumn stock is shot. Spring and autumn grouse densities are high. There is considerable investment in moor management.

Upland sporting estates usually have a mixture of interacting enterprises such as grouse, sheep, forestry and, in Scotland, deer and fishing. In Scotland on average 14% of the gross estate income is attributable to grouse shooting. There are estimated to be 4,578 people employed in grouse-related activities in Scotland, adding up to 978 full-time equivalent jobs. In context, there were 18,780 full-time workers on farms in Scotland according to the 1992 June census and a further 91,740 in England (MAFF *et al*. 1993). Keepers therefore form a small part of rural employment in total numbers, although they can make up a high proportion of the working population in economically disadvantaged remote situations (Egdell 1995).

The total number of keepers in upland counties of Scotland has fallen by 85% since the turn of the century (1901-1981), and by 67% between 1951 and 1981, associated with a similar decline in moorland area (Egdell 1995). On grouse moors, numbers have remained stable implying that the overall fall in keepers was from estates which no longer shoot grouse (Hudson 1992).

The level of revenue from a grouse moor depends on the following interlinked factors (Egdell 1995): the level of output (*i.e.* the number of grouse shot, which tends to be related to the numbers of keepers), the type of shooting undertaken, and the proportion of shooting that is commercially let. If the output is high, it may be possible for driven shooting to take place for which there is a greater demand and a higher price.

Annual management costs associated with grouse shooting are fixed, but incomes are related to red grouse numbers. The population cycles of grouse, with extremely high numbers in some years followed by very low numbers in others, can cause cash-flow problems for estates, during grouse population lows. Long-term declines in grouse densities have led to declines in revenues. The other main sources of revenue on most estates are forestry and sheep: lambs and draft ewes.

On the same piece of land, the sheep enterprise may be run by the farm tenant and the grouse by the estate directly. This may lead to conflicts of management, with the tenant's objective of maximising sheep numbers conflicting with the desire of game managers to have low grazing densities.

Egdell (1995) reviewed the implications of grouse moor economics for decisions regarding types of moorland management, drawing especially on the studies of McGilvray & Perman (1991) and McGilvray (1995). She concluded that:

- *'Available data suggests that many grouse moors are unprofitable. Whilst a significant proportion of moors will continue to be managed at a loss, because of the non monetary benefits they provide to their owners, other grouse moors are required to break-even to survive. The future of the latter moors is likely to be sensitive to developments or changes in economic conditions.*
- *A change in investment in a grouse enterprise could affect the area of the moor, the density of grouse on that moor, and the associated costs and revenue. Complete cessation of grouse shooting usually follows a gradual decline in investment in the grouse enterprise.*
- *It is estimated that more than half of estate owners have no incentive to change the management of their grouse moor in the foreseeable future, either because they are making a profit[3], or because they are willing to continue subsidising the shooting enterprise from their other income sources for the enjoyment of owning the estate and their own shooting. This category includes especially those who have inherited the estate, live elsewhere and have another source of income. They are likely to be more influenced by pressure on other sources of income, such as during a recession, than by the income from the estate itself.*
- *As many as one fifth of owners (those who have no other income and, usually, who have inherited the estate) will have an incentive to change the management of a loss making grouse moor by investing less in the moor, either resulting in a lower density of grouse on the moor, perhaps with more sheep or deer, or changing completely to forestry. Alternatively land may be sold.*
- *Perhaps a further fifth of owners will have an incentive to invest more in their grouse moor (usually through improving management to increase grouse density, by increasing the commercialisation of the shooting, or by increasing the grouse moor area).*
- *While all owners will aim to minimise running costs (and some will be unable to continue in ownership if they are not at least covering them) and will be concerned about the future of the estate if the shooting is deteriorating, the few owners without an alternative source of income will be particularly keen to maximise income.*
- *To help prevent loss and deterioration of heather moor, management of up to half the UK grouse moors could be significantly influenced by measures encouraging owners to invest more in their grouse moors or that take the financial pressure off those who are most likely to reduce their investment. However, moor owners with no incentive to change may take advantage of such measures without altering their behaviour, making it more expensive to encourage improvements in management or prevent detrimental land use change.'*

In summary, driven shooting of red grouse is a sporting tradition unique to the UK and, as such, attracts visiting sportsmen from all over the world with an associated economic input. A useful insight is provided by the *Study of the economic impact of sporting shooting in Scotland*, commissioned in 1988 through the Fraser of Allander Institute of Strathclyde University by BASC in partnership with the Scottish Development Agency. The study revealed (McGilvray *et al*. 1990) that, in addition to some 17,000 shooting participants active within Scotland, another 22,000 from the rest of the UK and 11,600 from outside the UK, visited Scotland each year for shooting. In terms of expenditure and benefits to the national economy, nearly £50,000,000 was spent directly by shooting visitors to Scotland. In turn, this expenditure generated significant employment and income within the shooting industry of Scotland and, by a multiplier effect, further employment and income elsewhere in the economy as a result of that expenditure.

Management to diversify habitat and potentially increase the numbers of black grouse would also diversify the possible source of sport-shooting related income.

3.1.6 The consequences of the loss of grouse moor management

Grouse moors make up a significant proportion of the heather uplands of Britain (see 3.1.4.2) and should a decline in red grouse bags lead to the collapse of this form of management in the uplands, there will be a variety of consequences.

Overall grouse management is associated with the following:

- economic activity and employment – discussed in section 3.1.5;
- retention of heather moorland itself and a lower rate of loss compared to other upland land uses – see section 3.1.3;
- the illegal control of some birds of prey – see section 2.3.4;
- management of heather by rotational burning (muirburn); and
- the legal control of game predators particularly foxes, crows and stoats.

Since the first three items have been discussed above, we pay particular attention to heather management and the legal control of predators.

The loss of grouse management is not unprecedented in the British Isles. Historically, red grouse were managed in Ireland during the 19th century (but records are sparse), and up until more recently on Dartmoor, Exmoor and more extensively in Wales. Since the loss of grouse management in these areas, there have been changes not only in grouse abundance and breeding distribution, but also in the abundance and distribution of other ground nesting birds which, in part share similar habitats to red grouse.

Within these regions there have been other concurrent changes, especially agricultural *e.g.* Lovegrove *et al*. 1995).

[3] McGilvray (1995) considered that there was little or no profit margin for Scottish grouse moors.

Thus, without conducting ecological experiments (which have been rarely done) it impossible to be certain of causal relationships.

3.1.6.1 Loss of red grouse abundance and breeding range

The best illustration in loss of grouse abundance is through the reduction of grouse bags which are dependent on summer grouse stocks. In Wales, red grouse bags have been well recorded. In the 1920s there were at least ten active grouse estates in Wales covering 8,000 hectares (Hudson 1992) and shooting 5,000 grouse per annum – Figure 3.14. Currently there are only two grouse moors with active management.

The breeding range of red grouse has contracted in all areas of the British Isles (Table 3.3) with the contraction evidently most extreme in those regions where grouse shooting has ceased.

Grouse moor management now only takes place to a significant extent in the north of England and in Scotland. In south-west England, red grouse are now only found in eight 10 km² squares.

3.1.6.2 Loss of other species associated with moor management

Hudson (1986) lists 15 species of bird (other than red grouse) which are associated with upland moor habitats, and he noted that all these would be lost where grouse moors were replaced by forestry plantations. However, should grouse management cease, and the uplands management simply be turned over to rough grazing, it is not clear which, if any, of these 15 species would suffer either declines in

Figure 3.14

Total number of grouse recorded shot from all known estates in Wales, 1900-1997.

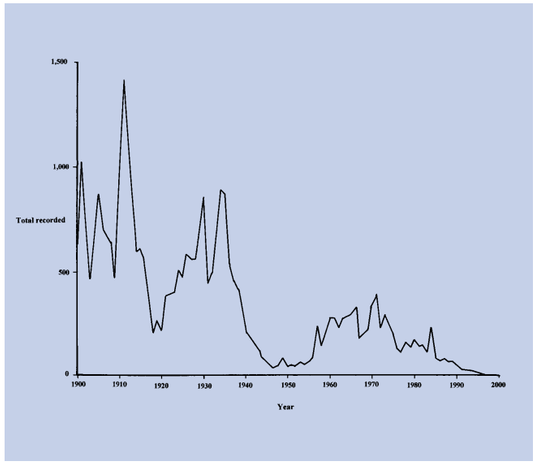


Table 3.3

The percentage decrease in numbers of 10 km² where red grouse were recorded present in survey period 1988-1991 compared to 1968-1972. Data from Gibbons *et al*. 1995.

Country	% loss of range between 1968-1972 and 1988-1991
Ireland	-66%
Wales	-27%
South-west England	-46%
North of England and Scotland	-11%

number or loss of breeding range. Brown & Bainbridge (1995) showed that, whilst grouse moors have been instrumental in protecting the uplands from the pressures of afforestation and agricultural intensification, important populations of many upland species are found on moorland managed for other purposes. Indeed, there is some evidence that these pressures are reduced where grouse management has been maintained – see section 3.1.3. Yet, it remains the case that very few, if any, bird species are entirely dependent on grouse moors *per se*.

The black grouse is a species of conservation concern (BAP priority list) that often lives along moorland edges. It has been shown to benefit from predator control by gamekeepers (Baines 1996) so a general loss of fox and corvid control can be presumed to affect this species adversely. Populations of black grouse in south-west England became extinct within the two decades between the two BTO atlas surveys (Sharrock 1976; Gibbons *et al*. 1993) and the population in the southern Pennines is retreating north.

The distribution and abundance of golden plover is closely correlated with red grouse moor management. There is a weak correlation between golden plover sightings on moorland, grouse density, and numbers of gamekeepers (Hudson 1992).

In Wales, ground nesting species which use moorland or moorland fringe such as curlew, snipe, lapwing, redshank and grey partridge, have all undergone population declines, and for some of these increased predation is thought to be an exacerbating factor (Lovegrove *et al*. 1995)

3.1.6.3 Potential effects on hen harriers

Of particular interest is the hen harrier which, in view of the extent of illegal killing, might be expected to increase substantially in number and in range once grouse management ceases (Etheridge *et al*. 1997). Grouse shooting has ceased in a number of areas:

- in the Republic of Ireland numbers have been declining – ascribed to forestry maturation (Gibbons *et al*. 1996);
- in south-west England they continue to be absent in spite of apparently suitable habitat and suitable prey-base (Watson 1998);

- in Wales the population remains substantially below what might be expected in relation to suitable habitat (Potts 1998);
- in Northern Ireland, where fox densities are high (Grant 1999), there have been recent increases (Sim *et al*. 1999); and
- in the Isle of Man, where there are low fox densities, numbers have continued to rise (Sim *et al*. 1999).

Roberts (1998) found that at Ruabon Mountain – a grouse moor that held the record for the largest bag of red grouse in Wales (7,100 in 1912) – the number of wintering hen harriers has declined over 20 years in parallel with red grouse numbers. In the early 1980s, when between 200 and 300 grouse were seen on counts, 0.9 hen harriers were also seen per census (12-15 contacts each winter). Later, after the abandonment of shooting in 1992, hen harrier sightings were down to an average of 0.11 over the five years after red grouse shooting stopped. Roosts of both sexes of hen harriers, however, have shown widespread declines often in areas not associated with game management (Meek *et al*. 1998; Watson & Rollie 1997).

There is, however, no general consensus as to the implications of loss of grouse moors for the conservation status of hen harriers. Etheridge *et al*. (1997) stated that there is significant illegal persecution associated with many moors; loss of such activity would reduce the current mortality and allow population increase (section 2.3.4). On the other hand, the results of the Joint Raptor Study (Redpath & Thirgood 1997) show that grouse management, in the absence of illegal persecution, is an inherently benign form of upland management for hen harriers. The exact consequences of loss of grouse moor management would depend on the extent to which it continues to be associated with illegal persecution. Green & Etheridge (1999) did not demonstrate a wide-scale effect of predator control by game management on hen harrier breeding success. However, it still may be asserted that fox control by gamekeepers improves the chances of hen harriers nesting successfully, and loss of fox control over large areas may reduce hen harrier nesting success. This issue remains unsolved, and the Working Group would welcome further wide-scale research, undertaken to investigate the beneficial effects of fox control.

In summary, although not conclusive, the evidence suggests that the distribution and abundance of a range of bird species is likely to change where game management is lost, based on the particular localities where this has happened.

3.1.6.4 Anticipated habitat changes if grouse moors are lost

Alternatives to the management of heather moorland for commercial grouse production are essentially agricultural (especially upland sheep production) and afforestation. The extents to which these alternative upland uses have been adopted have varied across upland Britain and, in part, reflect previous government policies.

In Wales there has been wide-scale agricultural intensification over the last two decades, one consequence of which has been hugely increased sheep stocking rates (Fuller & Gough 1999). This has had dramatic consequences for upland breeding waders (Lovegrove *et al*. 1995) with the wide-scale loss of formerly common species, whilst in moorland areas there has now been the complete loss of commercially managed grouse moors. (GCT and CCW have established a demonstration moor project on the Palé Moor within the Berwyn SSSI with the aim of restoring a viable Welsh grouse moor.)

In England, government policy to restrict the further expansion of upland afforestation in the late 1980s has resulted in less pressure from this sector. Where heather moors are no longer managed for grouse however, they have, in some cases, suffered from the effects of over-stocking by sheep and other forms of intensification which have resulted in loss of heather.

In south-west Scotland (as well as in other areas of Scotland), there has been wide-scale loss of heather moorland to coniferous afforestation. A variety of evidence suggests that there is a greater predator abundance within these new forests which, in turn, has negative effects on the birds of adjacent grouse moors, as first suggested by NCC (1986). It has been suggested that this leads to a 'domino' effect, since reduced grouse productivity, consequent upon increased predation from nearby forests, reduces the economic viability of the moor. This reduced viability builds pressure to change the use of the moor away from grouse production – often resulting in its sale for afforestation. In areas such as south-west Scotland and Kintyre the extent of afforestation is such as to bring in to doubt the long-term viability of moors now surrounded by large-scale afforestation. Parr (1992, 1993) demonstrated this predator 'edge-effect' from forestry in the context of predation on golden plovers nesting on a grouse moor surrounded by plantations in north-east Scotland.

Brown & Bainbridge (1995) noted that in the 1980s, the land-use alternatives in the uplands were either managed grouse moor on the one hand, or forestry or sheep ranching on the other. Policies for the uplands are now more complex and, at least in upland England, future wide-scale afforestation is unlikely. The ecological consequences for the abandonment of grouse moor management are thus far from clear.

3.1.7 Biodiversity Action Plan for Upland Heathland

As part of the government's national implementation of the Convention on Biodiversity, the UK Biodiversity Steering

Group has recently published Action Plans for Upland Heathland and Blanket Bog – both habitats on which there is driven grouse shooting (UK Biodiversity Group 1999).

In addition to maintaining the current distribution and extent of most of the current upland heathlands, targets have been set for habitat enhancement and re-establishment in order to increase the total extent of upland heathland by approximately 5%. These include the restoration of dwarf shrub heath on upland acid grasslands, as well as on areas lost to agricultural improvement and afforestation. Here the Action Plan gives emphasis to reducing fragmentation, and creating and maintaining blocks of upland heathland greater than 10 km². Dwarf shrub heath is also to be encouraged in temporary and permanent open ground, and in mature open canopy phases within existing woodland.

The development of native woodland and scrub will be encouraged on targeted areas of upland heathland where there will be a net benefit to biodiversity. Such areas may include those with less than 25% heather cover, heathland margins and streamsides, and areas where new woodland will contribute to woodland habitat 'networks'.

The Action Plan has a number of specific targets. It aims to:

- '*Maintain the current extent and overall distribution of the upland heathland which is currently in favourable condition,*
- *Achieve favourable condition on all upland heathland SSSIs by 2010 and achieve demonstrable improvements in the condition of at least 50% of semi-natural upland heathland outside SSSI/ASSIs by 2010 (compared with their condition in 2000);*
- *Seek to increase dwarf shrubs to at least 25% cover where they have been reduced or eliminated due to inappropriate management. A target for such restoration of between 50,000 and 100,000 ha by 2010 is proposed.*
- *Initiate management to re-create 5,000 ha of upland heath by 2005 where heathland has been lost owing to agricultural improvement or afforestation, with a particular emphasis on reducing fragmentation of existing heathland.*'

The Action Plan acknowledges that achievement of these targets will depend to a large degree on major reform of the Common Agricultural Policy (as proposed by the UK) together with other relevant policy and legislative changes.

Many specific actions are given, covering needs for policy and legislation, site safeguard and management, advisory and international activities, research and monitoring, as well as necessary communications and publicity. It is noted that, as a first step in plan implementation, more precise estimates of total extent of upland heathland, its distribution, composition and change need to be determined.

The plan estimates that current related expenditure is £3,514,000 primarily through agri-environment schemes. It anticipates that the plan's average annual implementation cost will be £9,353,500 during the first five years to 2004-2005 (giving a total expenditure to 2004-2005 of £46,767,700). The average annual cost over the following ten years to 2014-2015 will be £18,652,200 (giving a total expenditure from 2005 to 2014-2015 of £186,522,300). Three-quarters of the additional resource requirements are likely to fall to the public sector.

3.2 Potential solutions

The long-term decline in grouse stocks has been caused by loss of heather moors and reduced numbers of gamekeepers. While these factors need to be addressed, the Joint Raptor Study and events following (section 3.1.4.6) have demonstrated, however, that in some cases an increase in raptors can contribute to a suspension of driven grouse shooting.

For the Working Group to recommend doing nothing is not a sensible option. The Group's view is that this would not solve the problem of illegal killing of birds of prey or grouse moor management. Accordingly, we recommend a range of actions be undertaken by government, by its agencies and by others, which will positively address the current conflict.

3.2.1 Species management options: principles

As outlined in section 2.1.3, the Wild Birds Directive (79/409/EEC) (as amended) provides a legal framework for EU Member States for the conservation of wild birds. It is implemented by the Wildlife and Countryside Act 1981[4] in Great Britain, and the Wildlife (Northern Ireland) Order 1985 in Northern Ireland.

Article 5 of the Wild Birds Directive provides that Member States must establish comprehensive legal protection for all species. Article 9, however, provides a system of derogation (*i.e.* non-conformity with the terms of the Directive) from Articles 5, 6, 7 and 8 *'where there is no other satisfactory solution, for the following reasons:*

- *in the interests of public health and safety,*
- *in the interests of air safety,*
- *to prevent serious damage to crops, livestock, forests, fisheries and water,*
- *for the protection of flora and fauna,*
- *for the purposes of research and teaching, of re-population, of re-introduction and for the breeding necessary for these purposes,*

[4] As amended by The Wildlife and Countryside 1981 Act (Amendment) Regulations 1995.

- *to permit, under strictly supervised conditions and on a selective basis, the capture, keeping or other judicious use of, certain birds in small numbers.*'

The Working Group has considered a number of species management options and these are outlined below. Some would require a derogation under Article 9 of the Directive, and could therefore only be undertaken if no other satisfactory solution exists. While other satisfactory solutions exist, any derogation which would seek to reduce the numbers of hen harriers and other birds of prey to alleviate the predation of red grouse could not be granted. The primary motivation for any such derogation would have to be for the protection of flora and fauna.

The Group considered that there was legal uncertainty as to whether derogations under Article 9 of the Directive could be undertaken to protect a shootable surplus of grouse.

Clearly, before any derogations are issued, the effect of the derogation on the status of the species concerned would be taken into account. Before derogations to manage hen harriers to reduce predation levels on red grouse, account would need to be taken of the: current conservation status of hen harriers (in terms of numbers, range and breeding success); the effectiveness of appropriate habitat management; whether sufficient protection, including the designation of an appropriate number of SPAs was in place; and the impact of illegal killing. It would also be necessary to show that non-derogation routes were unsatisfactory.

Such solutions would require a scientific basis.

The Working Group agreed that to seek derogations to reduce hen harrier populations was not appropriate in present circumstances, as other satisfactory solutions had not been fully explored.

In the following section we report our consideration of the options, distinguishing between those that will require derogation and those which can be undertaken within current law.

3.2.2 Species management options not requiring derogation

There are a number of options that would not require derogation from the provisions of the Wild Birds Directive, and thus could be applied without further legal impediment. As solutions to problems on grouse moors, they are likely to vary in efficacy, cost and ease of application. We summarise the issues below.

3.2.2.1 Rear and release of red grouse

This option has been investigated recently by a PhD study at Aberdeen University (Price 1994), although the captive rearing of red grouse was demonstrated as long ago as 1911 (Lovat 1911 – *Grouse in health and disease*). The technique involves rearing red grouse in captivity, and then releasing the birds onto moors in summer. There are a number of practical difficulties in rearing birds in captivity, but most of these were overcome in the Aberdeen study; research earlier this century showed an 84% success rate in the hatching and rearing of chicks. The Aberdeen study initially found that 'released' birds were reluctant to fly and were vulnerable to predators, although during the study's last year however, 11% of released grouse were shot (albeit from very small samples – three birds were shot), representing around 40% of the total bag for the drive on one grouse moor. There do remain however a number of difficulties in releasing captive bred grouse, and any widespread move towards rearing and release of red grouse on a put-and-take basis may act as a serious disincentive for sporting interests to invest in moorland habitat management.

It is an offence, unless carried out under licence, to take grouse from the wild outside the open season; otherwise the activity would require a derogation.

3.2.2.2 Trap and transfer for restocking

This technique involves the restocking of local densities of red grouse by the transfer and release of birds trapped on other moorland areas. This is a technique currently being undertaken by a number of estates. It is a practical technique, and one that is likely to be useful where existing stocks are present (albeit that these may be at low densities). As above, it is an offence, unless carried out under licence, to take grouse from the wild outside the open season; otherwise the activity would require a derogation.

There is a need for a scientific study to review the efficacy of the technique.

3.2.2.3 Burning of, or interference with, nests not in use

It has been suggested that during autumn, after the nesting period, managers could burn out tall stands of heather which have held hen harrier nests, or those areas likely to attract hen harriers in the following spring. There is, however, no evidence to indicate that this practice, in itself, would deter hen harriers from nesting in the area in the following spring, and we do not recommend it.

Below the 450 m (1,500 ft) contour it is legal to muirburn between 1 October and 15 April inclusive[5]. This period may be extended to 30 April on the authority of the landowner or, in Scotland, of the Scottish Executive. Above 450 m the

[5] Muirburn is governed by the Hill Farming Act 1946, and parts of the Wildlife and Countryside Act 1981, the Wildlife and Countryside (Amendment) Act 1985, the Highways Act 1980, the Clean Air Act 1956, and the Health and Safety at Work Act 1974.

muirburn season is 1 October-30 April, extendable as above to 15 May. (The Moorland Working Group (1998) has recently recommended the advancement of the start of the burning season in autumn from 1 October to 1 September to extend the amount of time available for sensitive muirburn.)

The Group was uncertain as to the legal status of traditionally used nest sites outside the breeding season, particularly those of golden eagle, hen harrier, peregrine and osprey. We therefore consider that legal advice should be sought by government and its agencies to determine this issue, and clarify any uncertainty.

3.2.2.4 Diversionary feeding during breeding season

This technique involves putting out additional food for hen harriers to divert them from red grouse (Moorland Working Group 1999). Such prey can consist of carcasses of rabbits, mice, chickens or rats. No licence is required for this option, so long as the hen harriers are not disturbed at the nest whilst food is put out. At Langholm, experimental trials using this method have been undertaken in 1998 and 1999, and trials were also carried out at the Forest of Bowland in 1999. Food was placed on T-stakes in the centre of hen harrier territories, from territory establishment in late March until late May. Thereafter the T-stakes were placed at distances of 10-20 m from hen harrier nests until late July (Redpath *et al*. 1999).

Redpath *et al*. (1999) found that:

- There was little evidence that providing hen harriers with food in spring increased the breeding density.
- Hen harriers on the fed areas had larger clutches, though the difference was not statistically significant.
- Providing hen harriers with food in spring did not greatly improve adult red grouse survival.
- In summer, both male and female hen harriers reduced the rate at which they caught grouse chicks. Overall, harriers with food delivered 0.6 grouse chicks per 100 hours, compared to 3.8 chicks at nests without diversionary feeding.
- Feeding hen harriers in 1998 did not lead to an increase in grouse density in 1999. Numbers of red grouse on the moor in autumn has been declining steadily since 1993. In both 1998 and 1999, numbers of grouse chicks lost from early June to mid July was three times higher than expected from hen harrier predation rates. Some other unknown factor had a strong influence on grouse chick survival in these years.

The Heather Trust reported in a verbal presentation to the Group that the establishment of dovecotes on moors is apparently successful in reducing peregrine predation on red grouse in late autumn and overwinter. No good data have been collected, however, on the reduction of predation resulting from such diversionary feeding, and thus a scientific trial of such a method would be highly desirable.

The maintenance of such dovecotes would not be an offence under the 1960 Abandonment of Animals Act, as has been suggested, since the pigeons in these lofts would not be abandoned, and would be cared for by the regular provision of food and water.

3.2.3 Species management options requiring licences/derogation

A number of potential management options were considered by the Group which would require derogation from the relevant provisions of the Wild Birds Directive before they could be undertaken. This section summarises options, although it should be noted that none of these are proposed by the Working Group in present circumstances.

3.2.3.1 Conditioned food aversion

Conditioned taste aversion is a technique whereby animals are behaviourally conditioned to avoid taking and eating certain types of food (Reynolds 1999; Gill *et al*. 1999). Essentially, baits are laced with a chemical agent which makes the animal temporarily unwell causing it to be sick. Subsequently the animal is usually then put off this type of food permanently. Thus, bait of a dead prey species may prevent the killing and eating of that prey by a predator. The technique has the potential to be a powerful management tool, especially where individuals can teach this aversion to their offspring. Although there have been some successful experimental trials (Reynolds 1999), and the technique has been tried on raptors in captivity (Nicolaus pers. com.), there are serious difficulties to applying these methods to wild animals. Use of such chemicals in the field is regulated by the Pesticides Safety Directorate. Their constraints on experimental field tests require *inter alia* that the fate of the chemical is known, and that non-target species are prevented from taking baits. These and other conditions (*e.g.* Home Office experimental licence requirements) have slowed down progress in this field.

3.2.3.2 Temporary movement of hen harrier young to aviaries

One method that would temporarily reduce local hen harrier densities at the critical period of the breeding season, would be to take young hen harriers, just before fledging in May/June, into temporary captivity. Under this scenario, they would be cared for in large aviaries over summer before being released in mid/late August after the grouse shooting season has begun. They would be returned to the same moors from which they were taken.

3.2.3.3 Scaring in pre-breeding or breeding season

This could include putting out 'scarecrows' or firing carbide gas guns to deter hen harriers from settling to breed. The scaring, and potentially disruptive effects resulting from noise disturbance on other birds and human populations living nearby, would need to be considered.

3.2.3.4 Translocation of hen harrier eggs and young

This practice would involve the taking of hen harrier eggs and/or chicks, rearing them in captivity, and then releasing fledged hen harriers after a period of acclimatisation within the potential settlement areas.

Watson (1998) reviewed this proposal and concluded that it was technically possible and that it had been shown to work with other harrier species in France. In the UK context, however, it would be inappropriate in most areas in Scotland and the north of England as illegal killing would likely prevent success. In these areas, a cessation of killing would probably lead to fairly rapid settlement by hen harriers in any case. However, in some areas such as south-west England hen harriers may be absent through lack of population recruits. Some of these areas, which seem to have an appropriate habitat and an adequate food base, could be candidate recipient areas in a translocation scheme. However, Watson concluded that the scale of any translocation scheme would be insufficient in itself to re-locate all the hen harriers likely to cause problems on grouse moors.

The costs of the translocation are likely to be substantial given the need to monitor donor populations, settlement areas, and adjoining populations in order to determine the fate of any birds moved. Any application to translocate wild birds has to be viewed with regard to the IUCN guidelines for re-introductions (1995). This sets out guidelines that should be followed in advance of any trial programme of research.

We note the conclusion of Watson (1998) that translocation of hen harriers away from grouse moors is not likely to be an effective solution to conflicts with red grouse. We record our agreement with this conclusion.

3.2.3.5 Management of breeding success of hen harriers with a quota scheme

This proposal, suggested by the GCT (Game Conservancy Trust 1998; Potts 1998), would involve setting a requirement on grouse moors to achieve a set number of successful breeding hen harriers related to each area of moorland. When moor owners had achieved this requirement, the proposal envisages that additional nests over and above this quota could be removed through a regulated procedure run by government agency. This technique would require the destruction of fertile eggs.

3.2.3.6 Killing of individual raptors

The EEC Wild Birds Directive allows lethal control as a legal option only in particular circumstances. Any derogation for lethal control would need to consider a range of factors and would have a very high public profile. Thus, in the current circumstances, where not all other satisfactory solutions to conflicts have been tried, we have ruled out lethal control of raptors. It is important to note that such a proposal is not currently being made by any representative organisation with respect to moorland birds of prey.

3.2.4 Habitat management options

3.2.4.1 Managing hen harrier numbers through habitat

Results from the Joint Raptor Study indicated that the Langholm moors were especially favourable to hen harriers mainly since the mosaic of grass and heather encouraged high densities of voles and pipits that are important prey for hen harriers. Such high densities of hen harriers might not be expected on moors with more continuous heather cover. Where sheep grazing turns heather to grass-heather mixes – as has happened across much of the uplands (Figures 3.3 & 3.4) – it indirectly favours hen harriers. On moors where the heather-grass mixture is higher then there may be fewer hen harriers and more red grouse (Smith *et al*. 1999).

It follows that it may be possible, in the longer-term, to reduce the relative impact of hen harriers on red grouse by manipulation of moorland habitat to reduce the extent of grassland within heather by encouraging heather regeneration. Impacts of hen harriers on red grouse would be reduced as a result of two anticipated mechanisms:

- reduced settling densities of hen harriers in areas with low densities of their main prey, such as voles and pipits (which occur at greatest densities on grass-dominated moors), thus resulting in lower densities of these raptors on managed moors with extensive heather cover; and
- denser and more productive populations of red grouse, thus reducing the proportionate impact by raptors on the harvestable surplus of grouse (and hence on moor viability) to tolerable levels.

Given the recent findings (Smith *et al*. 1999) that red grouse nesting success is better where heather is longer, it appears that further research might be warranted to explore the detail of best heather management methods for grouse production. In particular, research into possible improvements of burning regimes and scales would be valuable.

3.2.4.2 Current management advice

The GCT, RSPB, English Nature and SNH have published a range of advisory and guidance materials on these practices. Growing numbers of estates are using these.

Grouse moor management advisory materials

- *Land management for upland birds*. English Nature (1996). Peterborough. Outlines benefits or upland birds.
- *The Grazing Index for heather moorland*. English Nature (1995). Peterborough. A consistent and easy way of assessing whether heather moorland is being grazed sustainably.
- *A Muirburn Code*. Scottish Natural Heritage (1996). Battleby. A widely used practical guide.
- *Good practice for grouse moor management*. Moorland Working Group (1998). SNH, Battleby. 24 pp. Valuable summary of major principles of good management practice.
- *Substitute feeding of hen harriers on grouse moors: a practical guide*. Moorland Working Group (1999). SNH, Battleby. 20 pp. Useful summary of diversionary feeding techniques.
- *A manual of red grouse and moorland management*. PJ Hudson & D Newborn (1995) Game Conservancy Trust, Fordingbridge. A valuable and well-illustrated guide to many aspects of moorland management.
- *Heather damage: a guide to types and causes*. AJ MacDonald (1993). Research and Survey in Nature Conservation No. 28, 2nd edition. JNCC, Peterborough. A valuable practical guide.
- *Farming and wildlife: a practical management handbook*. J.Andrews & M Rebane (1994). RSPB, Sandy. Contains a chapter on the management of hill and rough grazing.
- *Managing habitats for conservation*. WJ Sutherland & DA Hill (eds.) (1995). Cambridge University Press, Cambridge. Chapter 11: Upland moors and heaths (DBA Thompson, AJ MacDonald & PJ Hudson). A comprehensive chapter on upland habitat management.

- SNH Information and Advisory Notes on:
  - *Bracken control*
  - *Heather layering and its management implications*
  - *Heather re-establishment on mechanically disturbed areas*
  - *Cutting heather as an alternative to muirburn*
  - *Fences and upland conservation management*
  - *Heather moorland management for Lepidoptera*

SNH's Moorland Working Group has reviewed existing guidance on grouse moor management and nature conservation, and their conclusions were published in 1998 (MWG 1998). They recommended that the following key management objectives should apply to existing and potential heather moorland:

- *to maintain and enhance moorland biodiversity with a range of plants and animals, particularly those most characteristic of the uplands; and*
- *to contribute to the beauty of Scotland, and the enjoyment of its natural heritage, and to the benefit of its rural economy.*

For grouse moors, the additional objectives are:

- *to sustain grouse moors which are compatible with other countryside and biodiversity assets; and*
- *to maintain viable red grouse populations.*

These management objectives can be achieved by the following principles of good management. The Moorland Working Group noted that on many grouse moors, the prescriptions summarised below are not currently applied in a systematic or co-ordinated manner.

Management principles	Prescriptions
1 Regular, carefully targeted rotational burning	Burn suitable areas regularly Do not burn unsuitable areas (*e.g.* steep slopes, or sensitive habitats) Create intimate mosaic of heather patches of different ages on an 18-year cycle
2 Appropriate densities and active management of sheep across the hill	Active shepherding to avoid concentrations of sheep, especially on lower areas of the hill and in winter Movement of feeding stations every three weeks No more than 40% of annual heather growth to be removed by grazing animals each year
3 Integrated deer management	Co-operation between grouse moor interests and Deer Management Groups to influence reductions of deer numbers on grouse moors, not only to reduce grazing pressure, but also to reduce risks of tick-borne diseases in grouse
4 Fox, crow and other pest control	Legal pest control using relevant techniques (such as Larsen traps) to the benefit of many upland breeding birds
5 Managing and protecting raptors	Adherence to the law and the cessation of all illegal killing of birds and mammals
6 Tick and disease control	Provision of medicated grit for grouse to reduce strongyle infections Vaccination of sheep against louping ill Regular dipping of sheep against ticks
7 Bracken control	Physical control by crushing or cutting growing fronds on a regular basis Chemical control of growing fronds on a regular basis
8 Encouragement of open scrub and small, native woodland areas around the moorland edge and up stream sides, to encourage black grouse and other animals, as well as plants	Habitat creation to encourage diversification of game interests and wildlife benefits
9 Creation and retention of wet flushes and, where appropriate, blocking of existing moor grips	Creation and restoration of vital feeding areas for young grouse chicks and other wildlife
10 Heather restoration and regeneration	More extensive undertaking of heather moorland restoration
11 Managing impacts of land-use change on adjoining areas	Have regard for the impacts of forestry on muirburn and pest control programmes where adjacent to grouse moors

3.2.4.3 What incentives are needed to support appropriate management?

As densities of hen harriers, red grouse and other bird species are affected by land management, and as land management is influenced by the availability or otherwise of incentives, the scope and aims of existing incentive schemes are especially relevant to the resolution of problems.

Grouse moor owners already invest significantly in the necessary management of these areas but, if revenues from grouse shooting decline, they will be less able to do this. There is a range of current policy measures that can help provide incentives for better moorland management, although no incentive is specific to grouse moor management. We list some of these below. These incentives are targeted differently (*e.g.* at either owners or tenants/farmers), have different objectives and vary between Scotland, England and Wales. Thus their effectiveness in encouraging good management of heather moorland is likely to vary in a complex manner, and all incentives, of course, depend for their effectiveness on the reward expected.

We have reviewed these schemes (Table 3.4) with a view to assessing how existing financial incentive schemes might be specially focused on ways of encouraging improvement of quality and quantity of heather moorland habitat, and hence

providing better habitat for grouse and other species. As a result of our review we have come to the following conclusions:

Effectiveness of existing incentive schemes

1 There is a range of existing schemes that are targeted, in part, at retention of heather moorland. Some of those that have been in force over the last decade or more are clearly not working, and new measures (*e.g.* the Countryside Premium Scheme in Scotland) have recently been introduced. It is too early yet to say how effective these recent schemes are in reversing the current negative trends in quality and quantity of heather moorland[6].

2 Whilst a specific incentive scheme targeted at moorland management would be particularly valuable, the refocusing of existing schemes to include additional 'best practice' elements is perhaps a more realistic short-term objective that could be more rapidly put in place.

3 Learning from good practices in incentive provision across the British uplands would be desirable, especially more widely sharing of the lessons learnt from high quality schemes (such as English Nature's Wildlife Enhancement Scheme in the Northern Pennines).

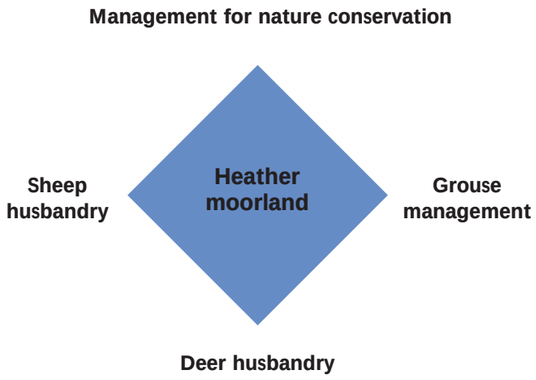
Scope and focus

4 There is no incentive scheme or other policy specifically designed to encourage the conversion (or reversion) of grass-dominated moorland to heather moorland, or specifically targeted at heather moors aside from their agricultural uses. Such a scheme would be highly desirable in the light of Habitat Action Plan targets (in particular, halting the effects of overgrazing and consequent soil erosion) as well as aiding the reduction of local settling densities of hen harriers (section 3.1.4.7 and 3.1.7).

5 Monocultural heather, however, is not a desired objective in terms of either game management or nature conservation.

6 In the development of future incentive packages for the uplands, there is a need for greater recognition of, and linkage to, UK biodiversity targets (for both habitats and species – section 3.1.7). Linkage to local (regional) Biodiversity Action Plans will be useful. Further, there is a need for wildlife benefits to be designed actively into management prescriptions rather than occurring incidentally.

7 Nature conservation (management for biodiversity), grouse management, deer management and sheep management can be considered as four axes of management on any specific heather moorland (below). Exact management activity will vary according to the importance given to each objective by the manager. Accordingly, there can be conflicts in desired management objectives for a heather moorland between landowners (grouse and game) and tenants (stock). Both of these management regimes can differ from specific conservation management requirements. Thus future incentives need to be targeted at both landowners and tenants.



8 Whilst a specific incentive scheme targeted at moorland areas would be ideal, the refocusing of existing schemes to include additional elements is probably a more realistic short-term objective that could be more rapidly developed. As noted by the Moorland Working Group, this might contain the following elements:

- funding for muirburn or cutting where appropriate to support grouse moor management. Well-practised grouse moor management requires a large number of small fires which require a heavy labour input;
- incentives to further encourage reduction of sheep densities;
- increased funding for fencing to contain and manage sheep around moorland edges (having mind that fences can cause mortality to capercaillie, red and black grouse);
- increased funding for shepherding to minimise local impacts of sheep concentrations;
- support for labour associated with stock control which promotes sustainable upland management;
- support for farmers who already take ewes off moorland areas in winter to be over-wintered on grasslands; support for shed construction costs to aid in-wintering of sheep, so reducing impacts on moorland;
- greater financial support for bracken control and follow-up treatments on grouse moors;

[6] For example, the end of the current phase of the National Countryside Monitoring Scheme in Scotland (Mackey *et al*. 1998) was 1988 whilst ESAs were first implemented in 1987. An initial Scottish Executive report on the effectiveness of ESAs in Scotland is due in late 1999.

Table 3.4

The range of schemes which may have impacts on heather moorland management for grouse in the uplands.

Scheme	Responsible organisation	Geographical coverage	Objectives	Target audience	Monitoring of efficacy?	Possible enhancements
Former Schemes						
Tir Cymen	Welsh Office	Wales		Farmers		
Environmentally Sensitive Areas (ESAs)	FRCA	Wales	Areas of high landscape, wildlife or historic value threatened by changes in farming practices.	Incentives are offered to farmers to adopt agricultural practices to safeguard and enhance the rural environment and create improvements in public access.	Yes	Now replaced by Tir Gofal
Heather Moorland Scheme	MAFF SOAEFD	England and Wales Scotland	Protection and improvement of moorlands by encouraging upland farmers outside ESAs to graze fewer sheep where this will improve the condition of heather and other moorland vegetation	Upland farmers	Regular checks to monitor compliance.	Uptake very poor in England/Wales – only 24 agreements covering 10,971 ha of heather moorlands with 7,647 seep removed from farms
Current Schemes						
Tir Gofal	Countryside Council for Wales	Wales	Whole farm scheme to maintain and enhance the Welsh agricultural landscape	Farmers and others who have control over farmed land (including owners, occupiers and tenants)	Yes	
Sites/Areas of Special Scientific Interest	English Nature Countryside Council for Wales Scottish Natural Heritage Environment and Heritage Service in Northern Ireland	UK	Maintenance of wildlife	Owners and occupiers of SSSIs	Common Standards for monitoring sites being implemented from 1999	
Environmentally Sensitive Areas (ESAs)	Scottish Executive	Scotland	Areas of high landscape, wildlife or historic value threatened by changes in farming practices.	Incentives are offered to farmers to adopt agricultural practices to safeguard and enhance the rural environment and create improvements in public access.	Yes – report on monitoring due late 1999	
	MAFF/FRCA	England – only six ESAs with heather moorland: North Peak Lake District South West Peak Exmoor Dartmoor Shropshire Hills	As above	As above	Yes	
	Northern Ireland	Northern Ireland	As above	As above	Yes	
Countryside Stewardship	FRCA	England and Wales		Farmers and other land managers		
Hill Livestock Compensatory Allowances	MAFF	UK	General agricultural support	Upland livestock farmers	No	

Table 3.4 continued

Scheme	Responsible organisation	Geographical coverage	Objectives	Target audience	Monitoring of efficacy?	Possible enhancements
Current Schemes						
Countryside Premium Scheme	Scottish Executive	Scotland	To encourage the adoption of environmentally-friendly farming practices and the management of particular habitats and features in the interests of conservation	Farmers, crofters and common grazing committees managing agricultural and outwith ESAs	Yes	
Wildlife Enhancement Scheme	English Nature	Some English upland SSSIs (*e.g.* North Pennine Moorland)	To maintain and enhance richness and diversity of heather moorland SSSIs, including restoration of degraded habitat of former interest	Owners and occupiers of SSSIs, especially farmers and game managers		Current uptake: about 120 agreements in North Pennine covering 40,000 ha with an annual budget of £250,000 (half spent on works or off-wintering)
Northern Uplands Objective 5b Project	Moorland Association (with EU and MAFF finance)	115,000 ha or moorland in northern England	To encourage development of integrated management plans of a environmentally and ecologically sustainable nature and thus move from intensive land management practices	Moorland landowners and managers		Budget of £4,500,000 over 10 years

- payments for wet-flush creation and enhancement;
- financial support for heather restoration practices;
- recognition of the practical difficulties associated with heather burning around sensitive areas, notably woodland and steep slopes, which otherwise have tall, leggy heather and which may hold low densities of grouse but may be of importance for biodiversity.

Thus all of these activities provide direct support for moorland managers as a positive element of local social support in the uplands as well as contributing to the delivery of nature conservation objectives.

Target setting

9 Any new incentive scheme or refocused existing scheme for moorland (above) should have a menu of options (*c.f.* ESAs) linked to the differing degrees of delivery of measurable local biodiversity targets (themselves derived from upland Habitat Action Plan and Biodiversity Action Plan targets).

10 The establishment of a national 'benchmark' or certification of high standards in habitat and wildlife management would be a valuable 'selling point' for those landowners reaching these standards – in ways comparable to the Organic standard for food or the achievement of the Charter Mark in the public sector.

3.2.4.4 Good moorland management: demonstration and training needs

This section outlines the purpose of such a programme of demonstration and training, and at whom it might be targeted to achieve its objectives. It also recognises that many different organisations are already providing training in various aspects of this field.

The objectives of training are to promote:

1 a widespread appreciation of the value and international significance of heather moorland and its natural heritage;

2 best practice in moorland management, including grazing and burning practices, and an understanding of the consequences of poor moorland management;

3 an understanding in public agencies, NGOs and relevant government departments of the economics and local social implications of positive moorland management;

4 an understanding of the complex relationships between active management for grouse shooting, heather moorland, biodiversity and the local economy;

5 best practice in legal predator control and methods of minimising the impact of protected predators upon grouse;

6 a sharing of experience and viewpoints amongst those involved in the management, use and enjoyment of heather moorland;

Table 3.5

Training topics related to good moorland management practices, and the target groups to whom this activity should be directed.

Training topics	Target groups for training and education					
	Moorland owners	Farmers	Gamekeepers	Conservation organisations	General public	Government agencies and departments
1 Best practice in heather management	X	X	X	X		X
2 The relationship between large herbivores and heather	X	X	X	X		X
3 The status of moorland birds	X	X	X	X		X
4 The European perspective upon birds and moorland habitat	X	X	X	X		X
5 The UK and international status of heather moorland	X	X	X	X	X	X
6 The role of public agencies and government departments In moorland matters	X	X	X	X	X	X
7 Parameters and importance of legal predator control	X	X	X	X		X
8 Availability of public funding to assist in moorland management	X	X	X	X	X	X
9 Achieving and maintaining the balance of factors influencing the health of heather moorland	X	X	X	X		X
10 The history of grouse shooting and its effect upon the development of heather moorland				X	X	X
11 The economics of heather moorland management				X		X
12 The economics of upland sheep farming				X		X
13 The perspective of moorland from the public's point of view	X	X	X			
14 The social value of heather moorland habitats				X		X
15 Public use of heather moorland						X
16 The consequences and cost implications in changing management practices and objectives				X		X
17 The need for positive management of heather moorland	X	X	X	X	X	X
18 The social importance of shooting, stalking and farming to upland areas				X	X	X
19 Access rights responsibilities and costs	X	X	X	X	X	X

7 a unity of vision for the future of heather moorland in the UK.

Target groups

The management of moorland occupies the interest of a diversity of people who may not share identical objectives. Most moorland interests fall within the following seven groups, and these should therefore be the targets for training and demonstration:

- moorland owners and managers
- conservation organisations
- farmers
- gamekeepers
- deer managers and foresters
- the general public
- government agencies and departments.

There is a need to:

a improve the application of good moorland management practices; and

b seek to reconcile divergent objectives and interests.

A programme of training, demonstration and education will therefore be diminished in value unless it addresses this problem, and includes interest groups who may not naturally consider themselves as appropriate subjects for involvement.

Topics for training

Some of the target groups, mostly notably moorland owners and managers, farmers and gamekeepers, may be regarded as having similar training requirements, although there may be

Table 3.6

Some organisations providing moorland management advice and training.

Organisation	Training demonstrations, publications and information available				
	Residential course	Training days	Demonstration projects	Publications for sale	Free information
The Game Conservancy	Three-day Grouse & Hill Keepers Course	Various days each year	✔	A wide range of publications	✔
The Heather Trust		Various training events ncluding formal conference	Involvement in numerous moors at varying levels incl. Full management roles	Numerous papers available on a wide range of moorland topics	
RSPB	RSPB contributes to courses and training days run by others by arrangement	RSPB day planned for 1999 (details not available)	Moorland management practised on a number of RSPB reserves	Habitat management guides	✔
Sparsholt College	Moorland management subjects included within syllabus of other courses including Gamekeeping				
Kirkley Hall College	Moorland management subjects included within syllabus of other courses including Gamekeeping				
Myerscough College	Moorland management subjects included within syllabus of other courses including Gamekeeping				
Thurso College	Highland Gamekeeping		Demonstration moor		
Borders College	Moorland management modules included within Gamekeeping and Rural Development courses				
Scottish Natural Heritage	SNH contributed to various training events and courses and will, by arrangement, design specific training packages			A wide range of publications	✔
British Association for Shooting and Conservation	No specific courses on moorland management but contained within scope of other courses		Arnfield Moor, England in association with the Heather Trust		✔

a need for differing emphasis within a particular subject. Table 3.5 relates training topics to target groups.

Existing sources of demonstration and training

A number of organisations are already playing significant roles in the dissemination of information and the sharing of experience. This may involve:

- formal residential courses – whether of several days duration or as part of a formal course of tuition lasting one or more years (most notably perhaps training for gamekeepers[7])
- individual training days
- demonstration projects
- literature, whether free or for sale
- information centre displays aimed at the general public.

The contributions made by some individual organisations is given in Table 3.6.

Implementation and strategy

Table 3.6 details organisations that already make a significant contribution towards education, training and demonstrations in the field of heather moorland management; many already co-operate and work together. It is, however, evident that an awareness, education and training programme, which is to contribute to a reversal in the decline of heather moorland in the UK, requires an agency to focus it, and to develop a strategy to stimulate the interest of target groups. The existing organisations are collectively and co-operatively capable of satisfying the needs of such a programme.

Recommendations

The lead agency for the co-ordination of actions under the Upland Heathland Habitat Action Plan should be tasked with developing and implementing a strategy of awareness, education and training devised to stimulate a reverse in the decline of the UK extent of heather moorland. This strategy should be focused on specific target groups to achieve an impact on all sides of the issues concerned, and taking into account the existing and potential contributions of organisations working in this field.

The success of the strategy should be measured against a stated range of criteria that take account of local social implications.

3.2.5 Integration of options

The Group considers that solutions to the problems caused by birds of prey on grouse moors will need to involve an integration of different approaches (including better enforcement of protective legislation and stronger penalties) operating at different scales and over varying periods of time. Given the contribution that properly conducted field sports and game conservation makes towards the maintenance and enhancement of the natural heritage and towards rural employment, partnerships will need to be established and maintained between all interested bodies in order to develop and implement the range of solutions that will be necessary.

To this end, the Group welcomes the document – *Action for Scotland's moorlands: a statement of intent* – recently signed by 14 organisations. Shared goals such as those expressed in that document are a valuable step towards achieving sustainable long-term solutions.

[7] Beginning in the early 1970s, the GCT started a series of five-day grouse and hill keepers courses every other year. These cover such subjects as heather burning, public access, controlling parasites and disease, legal predator control, management of deer and fish, and gun safety. In addition every year, the GCT runs at least two one-day courses on red grouse management. These are held at demonstration estates throughout the Highlands. At all these courses invited lecturers give presentations to back up the government Campaign against Illegal Poisoning of Wildlife.

4 Birds of prey and pigeons

4.1 Introduction

Those people who race pigeons have concerns about raptors because:

- peregrines and occasionally sparrowhawks can attack pigeons away from the loft, both during racing and training, which can result in the killing or wounding of pigeons and possible disruption of the flocks (*i.e.* if a peregrine attacks a bird in a flock the rest of the flock may scatter, and either take a long time or fail to return); and
- sparrowhawks will hunt close to some lofts and take pigeons which are exercising or at rest.

Evidence has emerged that a significant number of lofts are suffering attacks from sparrowhawks, and some lofts also from peregrines. Pigeons flying through peregrine territories can also be attacked. Tipplers[1] and tumblers/rollers[2] flown in such territories provide such easy prey that kits are commonly disrupted to the extent that in some areas predation has been claimed to be responsible for the abandonment of the pastime. The losses of domestic pigeons seem most severe in south-west England (especially Cornwall), Wales (especially the Glamorgan valleys), north-west England (especially Cumbria) and parts of Scotland where the densities of peregrines and pigeon lofts and race routes are high.

There is no doubt that certain raptor species kill racing pigeons although the extent to which this occurs is variable in different parts of the country and at different times of the year (Newton 1986; Ratcliffe 1993), and according to circumstance (Table 4.1). Wild, feral and domestic pigeons form part of the natural diet of peregrines, sparrowhawks and goshawks, although other raptor species in the UK rarely, if at all, kill pigeons. Raptors that feed on pigeons will not discriminate between wild/feral pigeons and those of fanciers, except insofar as the domestic birds may fall in the optimum size range as prey, and be easier to catch than their wild-living counterparts. Some are probably naive to predators, and some pigeon types may have had the natural predator avoidance responses bred out.

[1] Tipplers are pigeons bred for endurance flying; they fly round and round for many hours in the vicinity of the loft; usually in groups of three birds; 'kits'; the last kit to return to the loft is the winner. The total numbers of tipplers are not known as those who breed these pigeons are not organised into local or national clubs.

[2] Tumblers and 'Birmingham' rollers are bred for a predisposition to fly to a certain height and then spin to the ground. They are usually flown in groups of about 15 and are judged on the style of their fall.

Table 4.1

Summary of reported impacts by raptors on pigeons by species and location (from RPRA 1996; SHU 1998; Shawyer *et al*. 1999).

Species	In or at lofts (including exercise close to lofts)	During short-distance training	During long-distance racing
Peregrine	Some very local problems	Local problems, especially in Scotland, Devon, Cornwall, Wales, Cumbria and Northern Ireland	Significant problems in the west of Britain
Sparrowhawk	Significant local problems	No evidence of significant problems	No evidence of significant problems
Goshawk	Individual local problems	No evidence of significant problems	No evidence of significant problems

Pigeons are the primary prey of peregrines in Britain, largely because they are the most readily available; indeed Columba livia, which includes rock doves, feral and domestic pigeons, may form as much as half, by weight of the national average peregrine diet. Ratcliffe (1993) has estimated that peregrines could account for around 3% of the national racing pigeon population annually. In areas such as Devon, Cornwall, Cumbria, Wales and south-west Scotland, these numbers can be much greater, and regional variation can be considerable. Feral pigeons (which would include racing pigeons) tend to form less than 1% of the annual diet of sparrowhawks by numbers and weight (Newton 1986). Whilst the female sparrowhawk is larger than the male, both female and male sparrowhawks will attack racing pigeons.

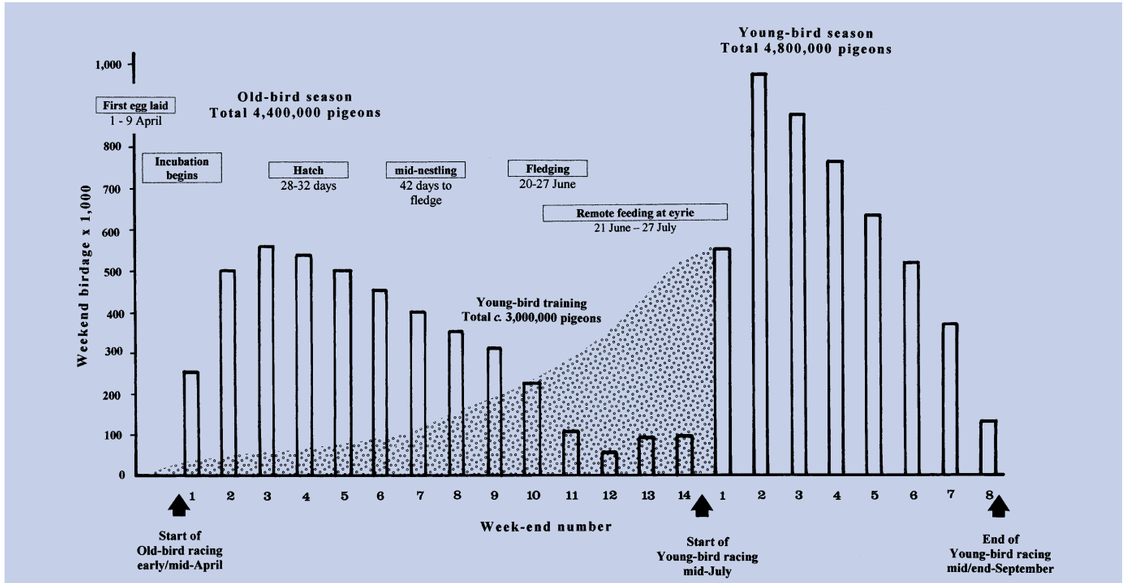
Without quantification of the scale of losses through direct killing, damage or causing the birds to panic, and without assessing the quality of birds lost (*e.g.* through examination of rings recovered from eyries), it has previously been difficult to evaluate the overall impact on the sport. Furthermore, to determine the relative importance of losses to raptors, losses need to be evaluated alongside the many possible alternative explanations for losses. Whilst racing or training these include:

- birds getting lost (*e.g.* due to poor weather, radio and magnetic waves, poor quality birds or racing practices);
- birds choosing not to return and joining the feral population; or
- birds dying *en route* due to fatigue (which may be exacerbated by poor weather), collisions with overhead lines (including those caused by pigeons panicking after attack by peregrines), shooting, or other predators.

Whilst at or near the loft other losses include birds being taken by other predators.

Figure 4.1

Timing and numbers of birds flown during the UK pigeon racing season (from Shawyer *et al*. 1999). 'Birdage' is the number of pigeons liberated during a race.



4.2 Pigeon keeping, scale, numbers and practices

4.2.1 Population status and trends of racing pigeons

Pigeon racing rose to popularity in the mid 19th century with the advent of the railways which allowed relatively easy transportation of birds to distant release sites. Pigeon fanciers have been seeking legalised control of raptors at least since 1925. Indeed, it was their calls for raptor control in 1959 which prompted the government-sponsored BTO survey that discovered the extent of the decline in the peregrine population due to organochlorine pesticides (Ratcliffe 1993).

The size of the national racing pigeon population in Britain is approximately 2.25 million at the start of the season, increasing by about 2.5 million young birds in September. This does not take into account pigeons that do not fly from lofts ('widowhood[3]' hens and stock birds).

There are about 75,500 pigeon fanciers in Britain and Ireland, just over 72,000 of whom are involved in racing (the others being involved with show varieties or in endurance or performance sports involving pigeons such as tipplers, tumblers and rollers) (Shawyer *et al*. 1999). Those fanciers racing pigeons operate from an estimated 54,300 lofts. Membership of the sport has been declining steadily at almost 2% per annum over the last 15 years.

The cost of a racing pigeon with pedigree varies from about £50 to over £100,000 plus VAT.

[3] Pigeons encouraged to fly back to the loft by being shown a potential mate, but not being allowed to copulate, and rewarded with copulation upon return.

4.2.2 Pigeon racing practices

Pigeons are raced during the season April-September inclusive divided into two 'seasons'. Between April and July, old birds (bred the previous year or earlier) are raced, whilst from July to September, young birds bred earlier in the year are raced. These younger birds are trained earlier in the year (from April onwards) (Figure 4.1). They are, however, exercised daily around the loft for one or two hourly periods.

4.2.2.1 Exercise around the home loft

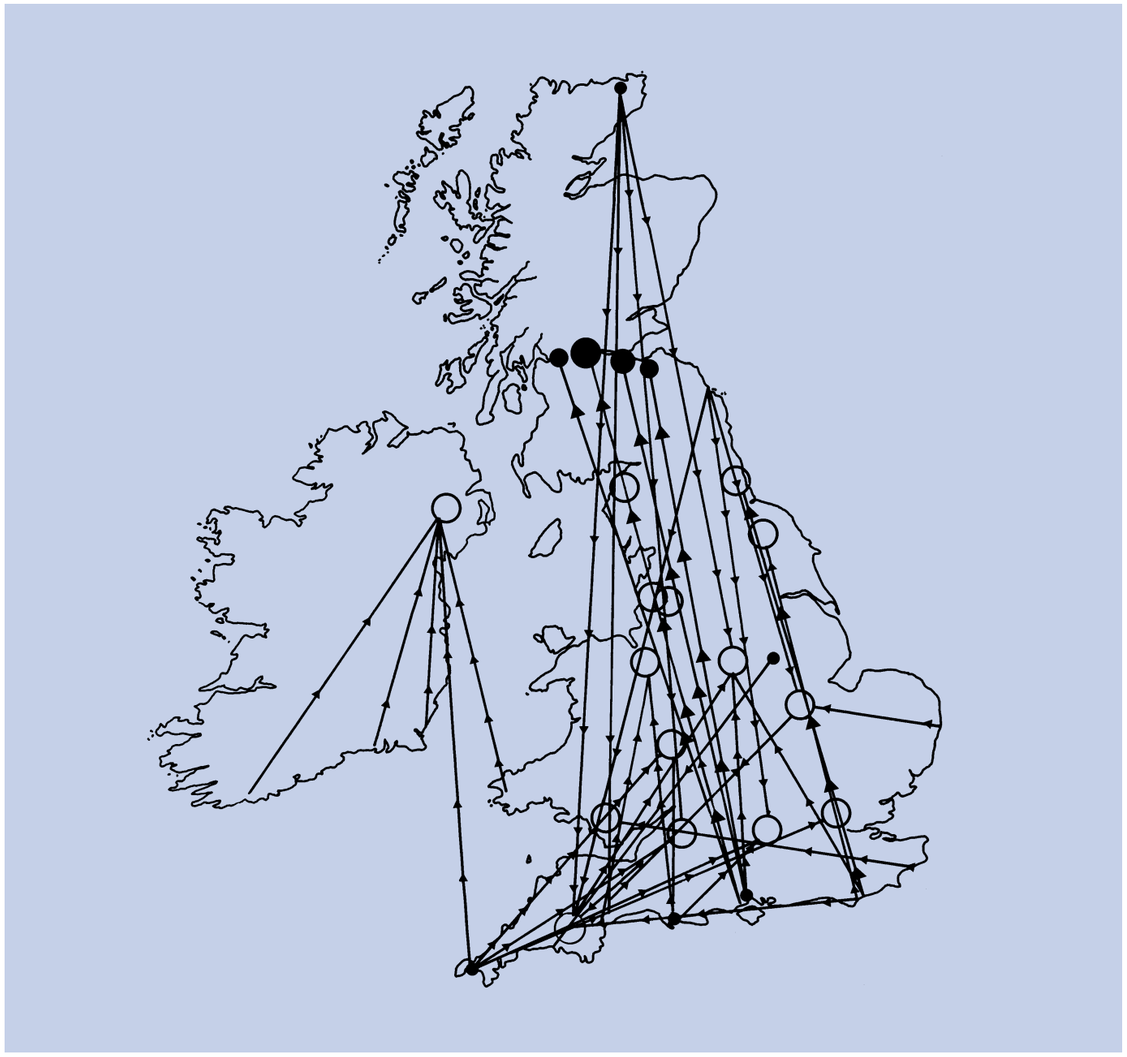
Pigeons are commonly allowed to fly freely around their loft usually as an integrated flock for two one-hour periods each day. In the early part of the year, young birds use the loft roof to acclimatise and, at this time, they can be especially vulnerable to attack. During the winter months, when the evenings are dark, many fanciers confine their birds.

4.2.2.2 Race training

Racing pigeons (mainly young birds) are transported at increasing distances from the home loft as the season progresses, and released to fly home in flocks or individually.

Figure 4.2

Map showing a selection of the pigeon race routes within the UK (from Shawyer *et al*. 1999).



4.2.2.3 Races

Racing pigeons are released at designated liberation sites to race back to their home lofts; the pigeon achieving the highest velocity wins the race. There are a large number of liberation sites around the UK, and traditionally locations have been used to achieve distances needed for competing in sprint, middle and long-distance races (Figure 4.2). Thus, many clubs in the south of the country use liberation sites in the north and *vice versa*. Those in the east, mainly race from liberation sites in the west and *vice versa*. To attain even longer distances, races are also flown from liberation sites in France, Ireland or occasionally Spain. The exact distance from each liberation site to the home loft is measured and, given the knowledge of release time, this enables the calculation of race velocities for each pigeon.

4.3 Research and legal advice

4.3.1 Previous research

Before the establishment of the Working Group, there had been relatively little scientific research undertaken on the interactions between racing pigeons and birds of prey in the UK. The only study has been that of Musgrove (1996, 1998) who published a PhD study of the interactions between peregrines and racing pigeons undertaken in the Bristol area between 1993-1995.

In their literature review of bird of prey issues (Annex 5), Hinsley & Redpath (1996) made two recommendations for further short-term research that would inform the current debate regarding the significance of predation upon pigeons:

a collation of information from pigeon fanciers on proportions of pigeons taken from lofts, proportions of fanciers affected and the main predators involved; also on proportions of pigeons returning from races, and on the seasonal change in the ratio of young to old pigeons in the national flock; and

b field trials of the effectiveness of aversive chemicals in protecting homing pigeons and game birds.

The first of these recommendations has been largely taken up by the DETR research project (Annex 7; Shawyer *et al*. 1999). The second has yet to be undertaken as a field trial (see Musgrove 1996, 1998).

4.3.2 Legal status of racing pigeons

DETR has taken legal advice as to whether racing pigeons can be classed as 'livestock' under the terms of the Wildlife & Countryside Act 1981. Section 27(1) of the 1981 Act defines 'livestock' as including any animal kept for:

a the provision of food, wool, skins or fur;

b the purpose of its use in the carrying on of any agricultural activity; or

c the provision or improvement of shooting or fishing.

Although this is an inclusive definition, DETR's legal advice, supported by MAFF, is that they would not class racing pigeons as livestock for the purposes of the 1981 Wildlife & Countryside Act.

Licences to kill or remove birds to prevent serious damage to agricultural livestock are issued under Section 16 of the 1981 Act, which implements Article 9(1) of the Directive. Article 9(1) refers to 'livestock', but the context is almost entirely agricultural. The Department's view is that racing pigeons would not be classed as 'livestock' for the purposes of the Directive.

Therefore, licences cannot be given for the taking or killing of wild birds of prey that might be killing or damaging racing pigeons.

4.4 Questionnaire and research results

4.4.1 Results from RPRA and SHU questionnaire surveys

The results of two questionnaire studies undertaken by racing pigeon organisations were presented to the Working Group.

The RPRA asked its membership to complete a questionnaire in 1996. It received 2,604 returns from people who said they had a problem with birds of prey. The Group received a summary report (RPRA 1996).

In 1996-1997, the SHU undertook a survey of its membership/clubs, circulating to 250 clubs (96% of the Scottish clubs) detailed questionnaires which had been drawn up following statistical advice. It received 1,937 returns, and the results were summarised in a detailed report published in 1998 (SHU 1998) which was submitted to the Group.

The RPRA questionnaire (RPRA 1996) and the SHU study (SHU 1998) identified that losses around the lofts of those who responded may be around 16%; the RPRA questionnaire concluded that annually over 14,000 attacks were witnessed around 2,604 lofts. In excess of 14% per annum of trained and experienced pigeons (two year old, or older) were lost in races within the UK to unknown causes (some of which may be predation), which pigeon fanciers deem to be an unacceptably high proportion. The SHU study confirms much of the RPRA questionnaire results, but also identifies the number of birds lost in training as 33,043 from 1,713 lofts. Of older pigeons lost in the SHU study, 2,422 (25%) had previously flown from release points at least 400 miles distant from home lofts.

4.4.2 Results from DETR commissioned research

Shawyer *et al*. (1999) undertook telephone questionnaires with 350 owners throughout the UK to establish details of pigeon numbers, losses and age structure of loft populations. There was a 95% response rate. Information on 786 pigeon casualties was obtained through examination of animal hospital records.

Pigeon rings were collected from 105 peregrine eyries in 1997 and 1998, and the life histories of 700 pigeons were requested from owners via a postal questionnaire. There was a 60% response rate, although this was regionally very variable (85% from SHU and North East England Homing Union members, but 33% only from south-west England). Life history information was thus derived for 366 racing pigeons known to have been predated by peregrines in the summers of 1997 and 1998.

Information on recruitment of racing pigeons into feral flocks was obtained by observations of 24,666 pigeons in 1997 at 137 sites.

Losses from lofts

Shawyer *et al*. (1999) found that losses occurred in both 'young' and 'old bird' race teams, from many and varied causes. Losses took place at the loft, during training and racing. In the UK losses of 'young birds' from all causes amounted to 27% in their pre-race period to July, and an

additional 48% of the remaining birds during their racing season, equivalent to an overall loss of 62% per loft. Losses of 'old birds', which start racing as soon as the season begins in April, amounted to 35%. Collectively, the annual losses of racing pigeons in the UK totalled 52%. This is close to expected annual mortality rates for a wild pigeon species (for wood pigeon see Murton 1965).

There was a highly significant difference between areas in the proportion of young birds lost from racing from all causes. Eastern England was proportionately the smallest (41% lost per loft) whilst Scotland had the greatest losses (57.8%).

Causes of racing pigeon mortality

It was established that a significant proportion of the losses from lofts (42%) could be attributed to straying, especially by young birds. This exhibited itself in pigeons taken to wildlife centres, being unable to fly and suffering from exhaustion and starvation, recruitment into feral flocks, and birds from lofts in the eastern half of England displaying acute westerly drift, predation being an eventual outcome. It was further revealed that ringed racing pigeons constituted 3.6% of the feral flock population in urban environments.

Of those birds that were lost, Shawyer *et al*. (1999) found that collision with overhead wires and solid objects, including vehicles, represented major causes of loss (40%).

The age structure of 'old birds' in both the feral flocks, and the casualties admitted to wildlife centres, showed no significant differences from the live loft population of racing pigeons in the UK. This indicated that pigeons two years old or more were just as likely as yearlings to be recruited into feral flocks, or fall victim to various hazards including predation. Predation by raptors mainly involved sparrowhawk, peregrine and goshawk.

Predation by sparrowhawks

Sparrowhawk attacks were reported as being carried out mainly by female birds and took place at or near the loft. Although attacks were reported in every month of the year, the majority (70%) occurred between March and June (before the onset of the 'young bird' racing season). Attacks at the loft by sparrowhawks occurred throughout the UK, and accounted for an annual collective loss of 2.7 'young' and 'old birds' per loft, equivalent to 3.7% of the combined 'young' and 'old' racing pigeon population in the UK. There was a highly significant difference between areas in the proportions of losses, with greater proportions lost in Northern Ireland (4.6%) and Scotland (3.5%) than in central and southern England (1.2%).

Although these percentages appear small nationally, where sparrowhawks do attack they return on a regular basis and losses to these lofts can exceed these proportions quite substantially.

Predation by peregrines

Eastern England was used as a control region to investigate the losses due to predation and scattering of racing pigeons by peregrines. In this region, both loft and race routes rarely coincide with peregrine territories. Losses in other regions were compared with the control in an attempt to determine those losses due specifically to peregrines.

In the UK as a whole, about 13 million racing pigeon prey opportunities are presented to 3,800 peregrines throughout the 22 weeks of racing, mostly at weekends. Numbers peak during the first weekend in August when almost one million pigeons are liberated into the sky above the UK.

In the UK, losses caused by peregrines accounted for 4.2% and 3.2% of the loft populations of 'young' and 'old birds' during their respective racing seasons. When pigeons from lofts in eastern England, which are rarely exposed to peregrines, were excluded from these calculations, loft losses for the rest of the UK amounted to 7.1% and 7.0% respectively. There was a highly significant difference between regions in the proportions of both 'young' and 'old' birds lost to all causes, with Northern Ireland and Scotland experiencing the greatest losses of between 15% and 20%. However, during the winter months, where pigeons are exercised around their lofts, predation rates at individual lofts can exceed these national percentages by a significant margin (RPRA *in litt*.).

The rings of domestic pigeons (all types) which were recovered from peregrine nest sites, following clearance of old rings from eyries before April, were used to examine the life histories and recent flight histories of pigeons preyed upon by peregrines. This revealed that attacks by peregrines were confined mainly to pigeons following their liberation in races (72%) rather than those in training flights or at the loft (28%). There were however, highly significant differences between the western region, eastern England, Scotland and Northern Ireland in the proportions of pigeons involved in these three pursuits (racing, training, or at the loft), which were lost to peregrines. Of those pigeons lost to peregrines (4.2% 'young' and 3.2% of 'old birds'), the western region[4] experienced the greatest proportional losses from the loft (15%), Northern Ireland from training (48%) and eastern England and Scotland from racing (80% and 95%). Shawyer *et al*. (1999) concluded that in Northern Ireland and the western region, a greater number of lofts were situated close to peregrines located at inland quarry sites. This made pigeons in these two regions proportionately at greater risk during training or exercising near their lofts.

Race feral pigeons (those pigeons which had been liberated a year or more before their rings were found in an eyrie), constituted 36% of the racing pigeons which were subject to predation by peregrines in the UK. Of the remainder (64% – those liberated during the year that their rings were found), 29% were flying on a direct line to their lofts, 26% were off-line of their racing/training route – and 8% had overshot their loft when they were preyed upon.

It was concluded that at least 70% of the racing pigeons which had been subject to predation by peregrines, were pigeons that had already adopted a feral existence, or had strayed significantly from their racing or training routes. The remainder (30%) of pigeons taken by peregrines were on a direct line to their loft and were more likely to have arrived home if they had not been subject to predation.

Predation by goshawks

Goshawk predation on racing pigeons was shown to occur most commonly in the spring. Pigeons can be captured in flight or on the ground, but very rarely at the loft. Because of the low population size and patchy distribution of goshawks in the UK, predation is localised. Where this occurs, losses from those lofts which overfly the main regions of goshawk distribution (the Peak District, northern England/Scottish Borders and Wales) are likely to be insignificant, except where lofts are close to a nest (Shawyer *et al*. 1999). Such a percentage would also include an unquantified proportion of recent strays and race-ferals.

Timing of predation

Analysis of the timing of predation showed that the start of the 'old bird' racing season coincided with the laying date (last egg date) for peregrines, and finished soon after their young had fledged. Examination of the liberation dates of the individual pigeons that were caught indicated that predation rates increased rapidly in the first week of May, around the hatch period, and remained at a fairly constant level through to the end of June at the time when the young vacated their nest ledges.

Comparison of the colours, sex and age structure of the pigeons preyed upon by peregrines showed no significant difference compared to the live loft population of racing pigeons. It revealed that within the 'old bird' sample, pigeons which were two years old or more were proportionately just as likely to be subject to predation as yearlings. This suggested that peregrines were not selecting pigeons by virtue of their age, colour or sex, but simply in proportion to their relative abundance.

There was also no indication that pigeons in long-distance races were any more vulnerable to attack than those undertaking short distances. Neither was there any obvious suggestion that birds of good quality (those which had previously won races and were from good race stock) were at less risk than those which had no wins to their credit.

Straying

Shawyer *et al*. (1999) concluded that straying, or the inability to home, is the major cause of racing pigeon losses in the UK. They suggested that clashing (the mixing of groups of pigeons flying in different directions, leading to some going off course) is the most likely reason for this phenomenon especially with young birds.

Although Shawyer *et al*. (1999) found no obvious racing pigeon characteristics which made particular pigeons more vulnerable to attack than others, there was a very noticeable trend, particularly in Scotland and Northern Ireland, for pigeons raced on the *Natural System*[5] to be especially prone to straying. Because straying from race routes and lofts appears to be a significant underlying reason for peregrine predation, it could suggest that the *Natural System* is in some way favouring this unwanted tendency to stray.

Fanciers racing birds on the *Widowhood System* were shown to have a much higher level of return success. That this system is designed to heighten the keenness of pigeons may simply mean that they are less easily diverted from their racelines (Figure 4.2) rather than that they actually possess any anti-predation attributes.

Summary

Shawyer *et al*. (1999) estimate that about 7.5% of racing pigeons are lost to raptors each year in the UK, overall losses due to all causes are about 52%. Shawyer *et al*. (1999) considered that failure to home, or straying, appear to be the most significant underlying reason for this high level of loss.

The Working Group received the following critique of the Hawk and Owl Trust (HOT) report from the representative of the RPRA.

This was not the agreed view of the Working Group.

Statement from the RPRA

The representative of the pigeon interests expressed serious reservations about much of the methodology and findings of the HOT research. In his view the samples used by the HOT rendered their findings not viable (HOT recorded less than 800 rings, as compared to the SHU and RPRA questionnaire which researched over 4,000 members, and whose findings they appeared to have ignored). In particular HOT's claim in their main report that the ageing of pigeons by ring colour was based on the RPRA ring colour because the RPRA issued 75% of the rings. It is wrong since the RPRA issued 68% of the rings (Table 4 of Shawyer *et al*. 1999). Therefore all inferences to two-year-old or older pigeons, in their analysis of recruitment to feral flocks, are suspect. This has the effect of confusing a two year old with

[4] Regions defined by Shawyer *et al*. (1999).

[5] Pigeons flying back to nest and mate at loft, or because of affinity to loft or eagerness to be fed.

a yearling, or even a young bird. Likewise pigeons two years old or older are, by the very process of two seasons training and racing, less likely to stray. Likewise the assertion that the 70% figure of pigeons taken by peregrines as being strays is fallacious (700 rings from 105 eyries over two years is less than four per eyrie per year). HOT claim they had responses from 366 owners of rings found in eyries – this is less than 50% of the total rings found. This questions the 70% figure. Sixty percent (HOT's figure) is therefore 256 replies which equates to 36% not 70%.

Likewise losses to collisions and other causes are unlikely to exceed 10% – the 40% suggested by HOT is deemed much too high and could result in them limiting their research to animal welfare clinics.

Finally, the contention that widowhood pigeons are less likely to stray is naive. It is an accepted fact that widowhood pigeons that fail to return to their loft within about 36 hours are rarely seen again – unlike natural pigeons who will often home as late as four weeks after liberation.

4.5 Potential solutions

4.5.1 Methods to ameliorate impacts by modification of racing/training practices

If pigeon fanciers release domestic birds into the wild then losses due to natural hazards (including predation) in the environment must be expected. The rarity of raptors during the middle part of this century has been an abnormal bonus for pigeon fanciers.

Any pigeon lost to wild predators represents a real loss, of either sentimental or financial value, to its owner. Understandably, fanciers seek to maximise survival of their valued birds. There are a number of possible approaches to achieving this aim, some of which have been identified by the DETR commissioned research (section 4.4.2, Annex 7).

4.5.2 Reduction of predation risk at or near the loft

i In situations where raptors frequently take pigeons from the vicinity of the loft, observations of the behaviour of the raptors could help to identify times of day, year or other conditions when there might be a risk of predation. Thus, at these times, release of birds from the loft would be avoided, or at least minimised. Together with the use of deterrents in the vicinity, this may make a useful contribution.

ii There would be benefits in comparing lofts that experience significant level of attacks from sparrowhawks with those that do not. Whilst proximity to woodland and other features may be the main cause of such differences, there may be other aspects of loft design or situation that could be more generally exploited to reduce local predation risk.

Those using non-lethal methods of deterring raptors from taking pigeons have already reported encouraging results and these may be valuable short-term techniques. SHU and RPRA have asserted that sparrowhawks and peregrines soon ignore deterrent devices, and eventually birds carrying these apparently become targets themselves (SHU 1998; RPRA *in litt*.) although this has still to be tested experimentally. Deterrent measures include:

iii Repellents and behavioural conditioning
In 1994, Musgrove (1996) completed a three-year postgraduate research project on the use and effectiveness of taste repellents in deterring peregrines from taking pigeons. This study sought to identify a chemical that is distasteful to peregrines, but harmless to pigeons, when painted on their plumage. The hope was that after taking one or two treated pigeons from a loft, a peregrine would learn not to take pigeons. The research has identified a chemical that appears to be harmless to pigeons but distasteful to falcons, inducing vomiting. A field trial on the Cheddar Gorge appeared to deter the resident peregrines from taking racing pigeons (A. Musgrove 1997). The method seems generally promising (Reynolds 1999; Gill *et al*. 1999), and should be investigated further.

iv Other deterrents
Attaching sequins to pigeon feathers, putting a model eagle owl in the vicinity of the loft, painting large eye marks on the loft roof or walls, and placing mirrors near the entrance are all methods which have also been tried but there are no published results of any trials (Musgrove 1996; Shawyer *et al*. 1999).

v Provision of alternative prey for peregrines and sparrowhawks
The establishment next to lofts of valuable pigeons of additional lofts containing less valuable birds, the loss of which is not of significance, is practised in some other countries. These additional lofts reduce the risk of high value birds being taken by providing diversionary prey for hawks and falcons.

4.5.3 Reduction of predation risk at or near the loft

vi Varying the times and starting points of training flights could make the pigeons a less predictable food source for the raptors, and releasing birds in several smaller groups may reduce the chance of losing many due to panicking in the event of a raptor attack.

vii In south-east Asia racing pigeons traditionally have fitted to their tails wooden devices, or Bali bells, which make a high-pitched noise when the birds fly and so deter raptors. Whilst these are now being marketed internationally, it has however been suggested that their effect has been found to be limited. Their use is not, of course, a practical proposition for actual races because they may slow down the pigeons.

viii Where possible optimise the locations (*e.g.* away from woodland), timing and numbers of pigeons released on training flights as a means of reducing sparrowhawk attack at the time of release, and peregrine attack on the return route to the loft. In particular, there are likely to be considerable benefits from significantly varying the timing and location of training releases so as to avoid the establishment of a predictable routine that can be anticipated by sparrowhawks.

A number of the measures listed in the previous section on lofts may also be valuable.

4.5.4 Reduction of predation risk during racing

ix High priority should be given to undertaking research into the reasons for straying. This is likely to be the single largest contribution to reduction of predation risk for reasons outlined in section 4.4.2, particularly for young birds.

x In the light of preliminary indications, research should be undertaken to establish whether or not the Widowhood System has the potential to reduce racing pigeon losses especially from straying during races.

xi To aid reduction of predation by peregrines, consideration should be given to delaying the start of the 'old bird' racing season by five weeks to the third weekend in May. This would avoid the current coincidence with the start of the peregrine's breeding season. In the long term, this has the potential to reduce predation levels by lowering breeding success and hence local densities of peregrines, particularly in areas where they are largely dependent on racing pigeons as prey (*e.g.* north-west England).

xii Where possible race routes are re-organised to maximise time spent flying in eastern England, thereby minimising exposure to peregrines (this is already being trialled by the SHU).

xiii Race routes are re-organised, especially for young bird racing, in an attempt to establish 'flight corridors' and reduce the current complexity (Figure 4.2) of north/south and east/west 'crossovers'. The current system has the potential to cause pigeons flying in different races, and in different directions, to clash and divert from their intended race lines, especially during calm or light wind conditions.

xiv Eye-spot markings
Transfers of eye-spot patterns, applied to each wing or the nape of a bird, are currently being marketed internationally (*e.g.* as 'Anti-Hawk Strike', 'Terror Eyes') to protect racing pigeons. Claims of their effectiveness vary; they seem to work until the raptor habituates to them (SHU 1998). A combination of butterfly markings with aversive conditioning might prove very effective. There is a need to undertake rigorous research trials with eye-spot deterrents on racing pigeons, particularly in the most vulnerable regions such as central Scotland, west and north-west England, Wales and Northern Ireland.

4.5.5 Integration of approaches

As with conflicts between birds of prey and red grouse, there is no single solution to conflicts between raptors and racing pigeons. A range of solutions will be necessary, and these will probably vary in efficacy both in time and in space. Thus, some of the possible solutions listed in the previous sections are likely to be more appropriate for application in Scotland than in England, and *vice versa*. Likewise, some may be of greater value in reducing losses during races rather than controlling predation at lofts. Nor in any one area will all the possible measures be equally effective.

We list all possible options, however, to indicate the range of approaches that may be worth further investigation at least on a local scale, even if these may not necessarily have national application.

4.6 Future scientific research needs

In nearly all of the possible solutions listed in previous sections, further research, conducted on a sound scientific basis, would be greatly beneficial. Such work would serve to 'fine-tune' possible solutions, and to learn from collective experience.

In reviewing the conflicts between racing pigeons and birds of prey, we were struck by the dearth of adequately executed scientific studies into the issues in the UK. There have been several descriptive accounts of the issues (*e.g.* the surveys of RPRA (1996) and of SHU (1998)) which illuminate the range and scale of the problems. The detailed scientific study of impacts and possible solutions undertaken by Musgrove (1996) and Shawyer *et al*. (1999) seem to be the only related studies to have been undertaken in the UK.

We recommend that the racing pigeon community take positive steps to encourage collaboration with scientists to undertake such research. This is a field of research of considerable public interest, and applied value, and there is

scope for a wide range of projects that could be undertaken, especially through collaboration with universities and other higher education institutions. The benefits of such collaboration could be considerable.

Initially such research could take the form of pilot trials of some of the techniques outlined above. Trials need to be undertaken based on current knowledge and, through monitoring results, progressively refined as experience and knowledge develops. There may also scope for useful international research collaboration.

Discussions are currently taking place between RSPB, SHU and RPRA concerning the development of a scientific programme to test deterrents around lofts, and whilst racing and training. The Group hopes such a collaborative programme can be agreed in the near future since this might act as a catalyst for a variety of studies as indicated above.

We note that aspects of the current ADAS research being undertaken into methods to deter predators from pheasant release pens (Annex 8; section 5.2.2) have close relevance to anticipated methods of deterrence of raptors from pigeon lofts. It will be important that information on effective methods of predator deterrence (and research methodologies) are shared between researchers working in both areas as well, of course, as lessons learnt from other relevant research (Balharry & Macdonald 1996; Reynolds 1999; Gill *et al*. 1999).

5 Birds of prey in the lowlands

5.1 The issues

In recent years, lowland game interests have raised a range of general concerns about the recovery of birds of prey numbers and their impact on lowland gamebirds. These centre primarily on predation at or near pheasant release pens (where young pheasants are kept after rearing in the period immediately before their release into the wild). A number of species gave cause for concern, particularly tawny owls, buzzards, goshawks and sparrowhawks.

The releasing of game birds is closely allied to habitat creation and preservation by shoot managers because game needs suitable cover outside of the release area to survive. For example, significantly greater areas of woodland have been shown to be conserved and planted where landscape is managed for shooting, compared with locations where shooting does not take place (Cobham 1997). Game shooting also provides a strong incentive for the uptake of agri-environmental schemes, particularly where such schemes incorporate elements designed to favour game as well as other wildlife *e.g.* conservation headlands. The Arable Stewardship Pilot Scheme, as devised by the GCT, RSPB and English Nature, is an excellent example.

To assist the Raptor Working Group's assessment of whether raptor species were giving cause for concern to game managers, BASC conducted a questionnaire survey of its gamekeeper membership in May 1996, covering both actual incidents and their perceptions of these. A total of 3,900 questionnaires was distributed. Of these, 1,193 (31%) were returned, of which 996 were used to avoid duplication from head and underkeepers at the same estates. These provided a new and up-to-date insight into the problems caused by raptors to game managers. With the encouragement of the Working Group, the results of this study have subsequently been published (Harradine *et al*. 1997).

Sixty one percent of the participating gamekeepers reported problems caused by raptor predation for the game management for which they were responsible.

Of particular interest to the Working Group was that concerns were greatest in the lowland areas and centred on raptor attacks, primarily on pheasants and partridges, in and around their release pens. In this respect the sparrowhawk, buzzard and tawny owl were involved in the majority of the reported incidents.

The following sections examine the question of raptor predation in the context of lowland game management.

Table 5.1

Best estimates of the status of UK lowland-breeding gamebirds. Population estimates all from Stone *et al*.

Quarry species	Best estimates of UK breeding population (pairs)	Birds of conservation concern status (BoCC)	Criteria for BoCC status (from RSPB ***et al***. 1996)	
			> 50% decline in UK breeding population or range over previous 25 years	SPEC 2 & 3 status: unfavourable conservation status in Europe (see Table 2.3)
Red-legged partridge	90-250,000	Green		
Grey partridge	140-150,000	Red	✔	✔
Pheasant	1,500,000-1,600,000	Green		

5.1.1 Population status and trends for lowland gamebirds

Table 5.1 gives details of population and status of pheasant, grey partridge and red-legged partridge.

5.1.1.1 Pheasant

The most common gamebird in the UK is the pheasant, which is one of our most widely distributed bird species. There are large populations of wild pheasants (originally derived from introduced stock), especially in the southern and eastern portions of Britain. In autumn, across the country, numbers are greatly increased by the release of birds hand reared for shooting. It is estimated that annually, 15,000,000-20,000,000 pheasants are released (Potts 1990; Robertson 1996). Pheasants are sedentary birds with the cocks establishing territories along the boundaries between scrub, woods and open ground.

The density of male territories is highest along the edges of woodlands rich in scrubby cover. Due to increased woodland planting and preservation, territory density tends to be greatest in areas managed for pheasant shooting. Modelling of pheasant breeding density in relation to regional variations in habitat quality suggests a British breeding population of 850,000 territorial males, 650,000 non-territorial males and 1,600,000 females (Robertson *et al*. 1989).

5.1.1.2 Grey partridge

Despite being a widespread species, the grey partridge has declined dramatically on farmland in the UK since the mid

1950s. The period 1969-1990 saw a greater than 50% decline to the estimated 150,000 pairs, now considerably less. The reasons for the decline are well known, and have been the subject of over 60 years study by the Game Conservancy Trust. Chick survival has been shown to be reduced by the indirect effects of herbicides and broad-spectrum insecticides (Potts 1986; and studies reviewed by Campbell *et al*. 1997). The ultimate cause of declines since the 1950s has been the use of pesticides and abandonment of mixed farming which together increase starvation of the chicks by reducing supplies of insects (Potts 1986). Although pesticides triggered the initial decline, chick survival was reduced to such an extent that wild grey partridge management was no longer sustainable. As a consequence predator control to protect grey partridges was largely given up in favour of rearing pheasants. Thus the GCT considers that currently predators (other than raptors) do in fact limit the numbers of grey partridges in most areas of suitable habitat in Britain, and this has been demonstrated experimentally (Tapper *et al*. 1996).

The grey partridge, however, responds quickly to favourable management – more often than not being instigated by shoot managers. With the GCT as the lead partner, a Species Action Plan is being implemented under the UK Biodiversity Action Plan. This is centring on considering the requirements of the grey partridge when establishing and reviewing agri-environment schemes, and encouraging land managers to create suitable conditions, such as conservation headlands.

Like the pheasant, many grey partridges are also reared and then released (Robertson 1996).

5.1.1.3 Red-legged partridge

Favouring the midland and eastern regions of England, the red-legged partridge has been scarce for most of the period since its introduction in the 18th century, only gradually reaching the present distribution by the 1930s. However, numbers were boosted from 1963 through the release of captive reared birds and, by the late 1980s, an annual total of 1,000,000 were being released each autumn (Potts 1990; Robertson 1996). This activity aims to maintain numbers of partridges shot in the face of declining numbers of grey partridge.

Red-legged partridges are less affected by the reduction in cereal crop insects than the grey, and this has helped them become established. On the other hand red-legged partridges are more affected by the predation of clutches during the breeding season, exacerbated by the reduction in predator control by some managers consequent on the decline of the grey partridge. GCT data suggest that there has been a marked decline in stocks of wild red-legged partridges since 1985, and follows the trend of recent declines in France, north-west Italy, Spain and Portugal, the other countries where it is found. The British wild stocks are estimated at approximately 90,000-250,000 breeding territories (Stone *et al*. 1997), amounting to approximately 750,000 individual post-breeding birds (Gibbons *et al*. 1993).

5.1.1.4 Legal status

The pheasant, grey partridge and red-legged partridge are all listed under Annex II/I of the Wild Birds Directive, which means that their populations can be hunted (subject to the provisions of Article 7 of the Directive).

In Britain, all three are afforded protection by the Game Acts outside of the specified open shooting seasons which, for pheasants, runs from 1 October-1 February inclusive and, for partridges, from 1 September-1 February inclusive. In Northern Ireland, hen pheasants and grey partridges are protected at all times by the Game Preservation (Partridge and Hen Pheasant Order) Northern Ireland 1967. Cock pheasants may be shot between 1 October and 31 January inclusive.

5.1.2 Lowland game shooting

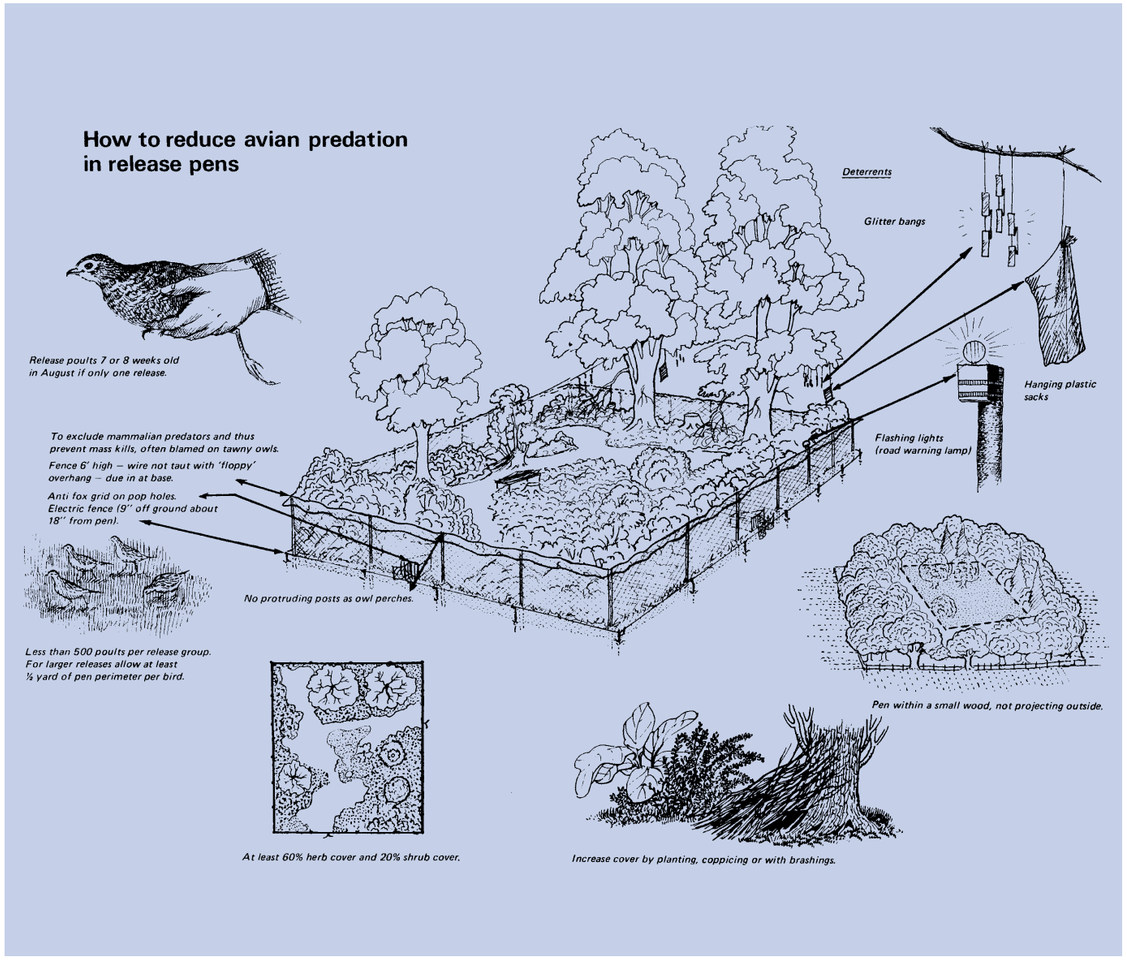
Game shooting is a widespread activity. For example, game is shot on 43.5% of agricultural holdings in England (Cobham 1997). Some shoots rely solely on wild pheasant and wild partridge populations to provide sport. Management practices concentrate on providing suitable habitats, mainly through ensuring sympathetic farming practices and the control of predators – notably foxes and corvids.

However, most shoots rely on the rearing and release of at least some game birds. There are estimated to be some 3,600 shoots in the UK that each employ one or more gamekeepers. These shoots will generally provide driven shooting where birds are driven over a team of standing guns. Many smaller and less formal shoots undertake this type of shooting. For example, BASC has over 1,000 registered shooting syndicates and is aware that some 54,000 of its 120,000 members shoot driven game each year. Many others shoot walked-up game, flushed by dogs. Again this will involve released birds although usually on a much smaller scale. The total annual bag of pheasants in the UK is probably well over 12 million, with the great majority derived from the 15-20 million released birds (Robertson 1996).

Game birds for release can originate from a number of sources. They can be produced from a shoot's own stock birds (*i.e*. eggs collected and hatched), can be bought in as chicks to be reared by the shoot, or bought in as 6-8 week old poults ready for releasing in July or August. From whatever source, pheasant poults in the UK are introduced into the wild via an open-topped release pen designed to acclimatise the birds to their new environment and, during this crucial period, to provide vital protection against mammalian predators. Typically, a pheasant release pen will be situated in woodland, and consist of a 2 m wire netting perimeter fence enclosing suitable natural cover, including

Figure 5.1

Pheasant release pen with 1970s good practice anti-predation recommendations made by Lloyd (1976b). Note that current work undertaken by ADAS (Annex 8) may modify some of these suggested practices in whole or part in the light of their detailed research findings.



trees to encourage a roosting habit (again giving protection from ground predators). As the birds mature they fly out of the pen but can return to its safety via specially designed grids in the fence. Before the start of the shooting season (1 October) birds will have been encouraged to leave the pen to forage and roost in the surrounding areas.

The Game Conservancy Limited Advisory Service recommends a pheasant release pen density of no more than 600 birds per hectare (100 m by 100 m). Using large pens minimises mass kills by mammalian predators, feather picking, and the build up of disease and impact on ground flora (Carroll & Robertson 1997). Poults at release age have a cost of at least £2.50 each. Each pheasant shot has a financial value of up to £33 (derived from the average value of let shooting divided by total bag size), indicating the additional revenue that may be derived from the rearing and release of pheasants.

Partridges tend to be released in a different system, involving smaller covered release pens in the more open country (stubble) favoured by this game bird. The aim is to keep small groups or coveys of partridges together once they have been released. This is achieved through releasing one or two birds at a time, and providing food and water so that they stay in the vicinity near to the remaining birds in the pen. This method is being used on a number of shoots to supplement or re-establish grey partridge populations to sustainable levels.

5.1.3 Impacts of birds of prey on lowland game

The BASC survey was reported by Harradine *et al*. (1997). Noting that the report did not set out to assess losses to other causes of mortality such as mammalian predators, road kills and disease, the key findings were:

a Sixty-one percent of the 996 gamekeepers who responded to the survey (31% of those circulated) reported problems in the survey year of 1995 caused by raptor predation for the game management for which they were responsible.

b The great majority of reported incidences involved pheasants (64%), with most of the rest involving partridges (18%) and grouse (13%).

c Over half (51.2%) of the reported incidences involved game bird release pens (that is attacking and killing or damaging young birds therein) and nearly all these were pheasants.

d Sparrowhawk (36%), buzzard (20%) and tawny owl (17%) were dominant in the incident reports. Reports of goshawk incidences were less (8%), probably reflecting this species current limited range rather than its propensity for attacking game.

e A marked seasonal pattern appeared in the reported incidences. This relates closely to the availability of stocked release pens containing pheasants and partridges in the late summer and early autumn, as well as the availability of growing birds both outside pens and newly released.

f With some of the reported incidences (Table 5.2), it was possible to quantify the loss of pheasants and partridges attributed to raptors.

g Concerns were widely expressed over the indirect effect of raptor attacks. Many gamekeepers reported on the stress caused to other birds not directly attacked, resulting in injuries caused by panic, reluctance to feed or come to roost, and widespread dispersal outside the pen commonly resulting in further losses due to predation, primarily by foxes.

h The 38 wild partridge shoots participating in the survey reported 49 incidents involving raptors in 1995. Some 93% of the reported incidences involved the killing mainly of adults (67%), the rest being of an unspecified age. The main raptor species involved in these incidences was the sparrowhawk.

There have been few other studies of the scale of the impact of raptors on lowland game birds and game bird management. Lloyd's (1976) study for the British Field Sports Society, Game Conservancy, RSPB and the Wildfowlers Association of Great Britain and Ireland (now BASC) gives some comparative data. These came mainly from East Anglia, the Midlands and from both a selected and self-selected sample of estates.

Tawny owls, sparrowhawks and buzzards, in that order, were most involved in attacks on pheasants, although not all the losses reported could be assigned to these or other raptors. Mammalian predators were also involved to some extent. Reported losses to raptors were broadly similar to those in the 1996 BASC study in that more than half the

Table 5.2

Details of reported losses of gamebirds to different species of raptor during 1995 from those estates reporting raptor problems, and providing data on both numbers of gamebirds released and numbers lost to raptors (from Harradine *et al*. 1997).

Note: the actual losses may be substantially higher in some cases as many keepers reported losses of several birds a night over a period rather than specifying the actual numbers involved.

Species	Raptor	No. of shoots affected	Mean % loss	Min.	Max.
Pheasant	Sparrowhawk Buzzard Tawny Owl	211 147 199	2 3 2	0.05 0.02 0.07	20.0 46.7 15.0
Partridge	Sparrowhawk	90	8	0.02	70.0

estates suffered losses of over 0.5% of released birds, but a significant number (10%) suffered losses of 5% or more, with some of over 10%. Overall, Lloyd estimated raptors accounted for some 5% of known pheasant deaths. It should be noted that since Lloyd's study several raptor populations have recovered in both size and distribution, therefore increasing the potential for conflict with game management.

Losses of game birds to raptors clearly continue to occur. They are considered by keepers to be a problem for game and shoot managers, although the full attribution of these losses has yet to occur. Nevertheless, they also focus attention on the need to put into practice measures to reduce and control the problems at source.

5.2 Potential solutions

5.2.1 Methods to ameliorate impact by modification of release pens and practices

Preventative measures were investigated in Lloyd's (1976) study. He concluded that, at least with respect to problems with tawny owls, releasing more mature poults, maintaining high levels of escape cover in ground vegetation within the release pen, and the use of scaring deterrents were variously important in reducing losses to raptors. In particular, the use of hanging devices, lights and bangers were of limited use over the long term, but their potential value lay in utilising the temporary scaring effects on owls (and sparrowhawks) to protect pheasant poults until they were old enough to escape much of the raptors' attentions. Alternative feeding was also suggested as of benefit in reducing sparrowhawk depredation.

It is clear from the BASC (1997) study that many of the measures used in the 1970s, particularly the various forms of scaring, are still being used but with varied success. The

returns from the 1997 survey show that, of the 996 used returns, 607 reported incidents of raptor predation. Of these, 102 (17%) took no action. A total of 15% did not indicate whether they took action or not, whilst 68% took some form of action to prevent and deter raptor damage. Scaring devices such as bangers, gas guns, alarms, hangers and mobiles, lights, mirrors, scarecrows and human presence are all being used. Measures are also taken to protect release pens, including installing overhead wires, tapes, and nylon lines, as well as removing branches used as perches by raptors. Again, all of these have varying success depending to a degree on the species being combated. Some keepers reported success with buffer feeding by providing buzzards with dead rabbits as an alternative food source. Little success of scaring devices was reported against goshawks, although it is known that some gamekeepers have developed electronic devices that are claimed to be successful.

It is notable, however, that some of the most commonly used preventative measures were those which appeared to be least successful, and some of the most successful measures were less frequently used. This may be because game managers are no longer aware of Lloyd's (1976a) recommendations, or lack confidence in them. Whilst Lloyd (1976a) made a series of recommendations regarding pen protection, the relative efficacy in reducing predation losses of the different methods suggested was not experimentally tested. The current work undertaken by ADAS (Annex 8) may modify some of Lloyd's recommendations, in whole or in part, in the light of their detailed research conclusions. Pen protection appears to offer a means of excluding raptors from release pens, but is said to be limited in application on the grounds of practicality in relation to the recommended size of pens and the need to allow pheasants to leave the pens naturally through the open top as they mature.

Fifty-three percent of the keepers who responded made no suggestions as to further management measures which could, or should, be implemented to ameliorate raptor predation on lowland gamebirds. Of the 48% of keepers who suggested that further measures to control the problem they were experiencing from raptors were necessary, over three-quarters felt that population control, or killing of individual troublesome birds, was necessary. BASC interpret this as a manifestation of a widespread level of frustration amongst gamekeepers having to cope with these problems when they are under pressure to manage their game and shooting interests both within time and financial constraints. It is probable that in some cases this frustration manifests itself in illegal measures being taken.

If non-lethal deterrents are to be viable and have wide acceptance, then there is an urgent need to establish their efficacy – *i.e.* to determine clearly which method, or combination of methods, is most effective against which species of raptor, and in what circumstances – so that clear and concrete advice can be given in which gamekeepers can have some confidence. Clearly this position has not yet been reached.

In this context it should perhaps be noted that legal advice taken by the Raptor Working Group has confirmed that game birds within release pens, or otherwise reliant on man for food, are classed as 'livestock' in the context of the Wildlife & Countryside Act 1981. As such, under Section 16(k) of the Wildlife & Countryside Act game managers could apply for licences to kill or remove sparrowhawk, tawny owl or buzzard in the context of responding to serious damage being caused in release pens. The consideration of such an application would involve a requirement for the applicants to have shown that they had tried all other suitable alternative non-lethal methods to address the problem, *i.e.* in the terms of Article 9 of the Wild Birds Directive, that there was 'no other satisfactory solution'. However, as has been established above, there is currently no source of concrete or substantiated advice on this subject, and this would need to be in place before any licensing solutions could be considered. The degrees of threat to, and status of, the bird of prey population involved would need to be considered also. There remains a need to develop guidelines on what constitutes serious damage in the context of raptor predation in pheasant or partridge release pens.

5.2.2 Future needs

Research

The focus of the concerns in the lowlands relate to predation around pheasant release pens. There is therefore a need to address the real and perceived raptor problems in and around pheasant release pens. Traditional non-lethal preventative measures continue to be used. These, however, have not been subject to objective assessment to determine the extent to which they consistently and reliably reduce problems experienced from raptors to acceptable levels. Such an assessment is needed to allow advice to be formulated. Accordingly, and in the light of the issues raised by the BASC questionnaire, a research proposal was drafted by the Working Group in 1997. The aim of the work is to improve the effectiveness of management techniques to minimise losses of young pheasants caused by raptors in and around pheasant release pens (Annex 8), and to examine means of mitigation and ways to improve the effectiveness of management techniques.

The study began in May 1999 with funding from BASC, DETR, SNH, National Trust and the RSPB and the final report is scheduled for 2000. The contract was awarded to the Agricultural Development and Advisory Service (ADAS).

The specific objectives of the project are to:

- determine the actual losses of pheasants to raptors both within and around release pens on a sample of shooting estates;

- determine the losses of pheasants to other predators or by other means as a result of the attention of raptors in and around the release pens;
- assess the raptor-related losses of young pheasants from release pens in relation to total losses from all sources;
- assess the economic and other consequences of the losses of young pheasants to raptors to the game management interests of the estates;
- determine the relative effectiveness of different deterrent and other management techniques in and around the pheasant release pens in reducing the attentions of raptors;
- assess the cost effectiveness of each of those techniques; and
- provide advice to game managers on the best techniques to minimise problems from raptors in and around pheasant release pens.

Dissemination of best practice and research results

From the BASC survey and other information presented to the Working Group, it appears that many lowland game managers are no longer aware of the conclusions of Lloyd's (1976a) study. There is a need to ensure that its conclusions, as modified and enhanced by the current ADAS research study, are widely promulgated through the publication of updated 'best practice guidance' – perhaps jointly produced by a range of interested organisations to ensure wide dissemination. Indeed, given that deterrent methods known to be effective are not widely or consistently used, highlights the need to ensure that recommendations that arise from current research (Annex 8) are widely and appropriately disseminated at the conclusion of that work.

6 Birds of prey and songbirds

6.1 The issues

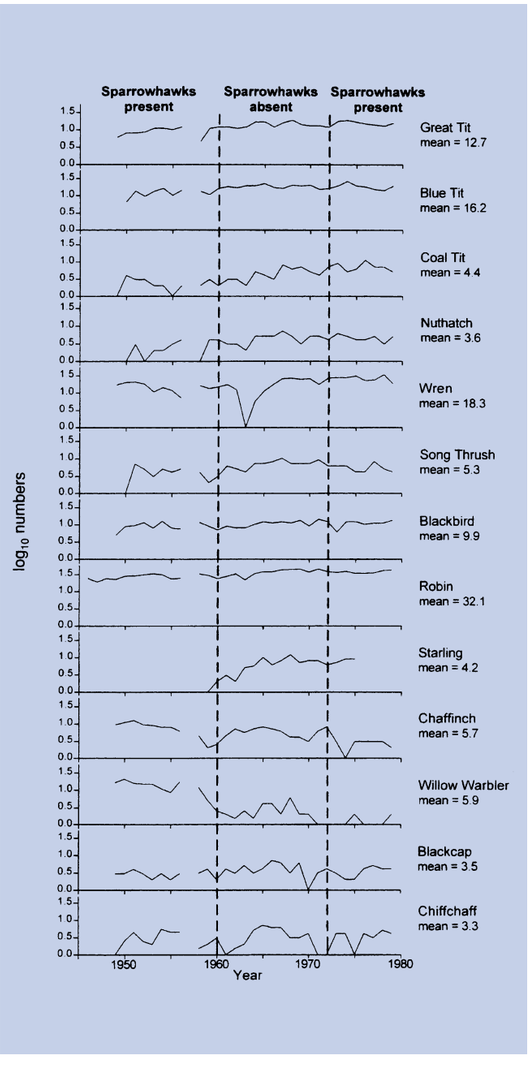
During the last 30 years there have been marked declines in the populations of many British songbirds, especially on farmland, while one of their main predators, the sparrowhawk, has spread back into areas from which it had previously disappeared. Given the coincidence in timing it has been suggested that increased predation might have been responsible for the declines. In the light of the wide public interest in the alleged role of birds of prey in the decline of these songbirds, the Group briefly considered these issues even though the topic was not a formal Term of Reference. It has received a number of written submissions and papers, and an oral presentation from the British Trust for Ornithology (BTO).

We are aware of no published scientific evidence that avian predators can have sustained effects on the size of songbird breeding populations (Newton 1993). Even long-term studies have failed to find a link between changing songbird breeding populations and sparrowhawks (Newton *et al*. 1997). The widespread reduction in sparrowhawk numbers in the years around 1960 was not obviously associated with a consequent large upsurge in songbird populations, as would have been expected if hawks limited songbird numbers (Figure 6.1; Hinsley & Redpath 1996; Newton *et al*. 1997). Following successive restrictions in the use of organochlorine pesticides over the period 1962-1986, sparrowhawk numbers recovered, beginning in the western counties of England in the late 1960s and reaching East Anglia in the late 1980s (Newton 1986). At least the latter part of this recovery coincided with a period of massive decline in some songbird populations.

Hinsley & Redpath (1996) reported two relevant broad-scale findings. Firstly, although sparrowhawks hunt more in woods than in open country (as shown by radio-tracking), in the Common Birds Census (CBC) data substantial declines were almost entirely restricted to farmland birds. Most woodland species maintained their numbers throughout. Of the 16 species whose populations had declined by more than half since the 1960s, only three (house sparrow, starling and song thrush) figure prominently in sparrowhawk diets, both in former and more recent times; the remaining species were taken in much smaller numbers or not at all (Newton 1986). Most major prey species are among the non-declining birds. Secondly, while in several species declines were evident from the 1960s, and may have started even earlier, in most species declines started around the mid 1970s. In eastern counties of England, this was at least ten years before sparrowhawks began to return.

Figure 6.1

Counts (log values) of various songbirds in a 16 ha oakwood plot each year during three successive periods when sparrowhawks were present, absent and present. Mean values show average numbers of singing males (untransformed numbers) present each year over the whole period. For most species, the first counts were made in 1949 but, for robin, counts were also made in 1946-1948, for blackbird and chaffinch in 1946, and for wren in 1948. No counts were available for any species in 1957, and none for starling after 1976. From Newton *et al*. (1997).



New studies by the BTO (Thomson *et al*. 1998), using CBC data for a wide range of songbird species, were presented to the Group in 1998. These overcome the problems of most previous studies that were short term or

Table 6.1

Causes of recent population declines in some bird species of European farmland[1] that have been studied in detail. Updated from Newton (1998).

[1] Note that the basic ecology of these species occurring on European farmland outside the UK is similar to that within the UK.

[2] Supported by experimental evidence.

[3] Additional suggested cause: greater nest destruction through earlier grass cutting for silage.

In addition to the above species, two other declining farmland birds that have been studied include the corncrake and stone curlew, in both of which farm mechanisation was found to be the primary cause. Tractor-drawn grass-cutting equipment greatly increases the mortality of young and adult corncrakes, causing population decline (Norris 1945; Green 1995; Green & Stowe 1993), while spring harrowing of arable land destroys the eggs of stone curlews, causing population decline (Green 1988).

Species	Crucial food-supply	Cause of reduction in food-supply	Mechanism of population decline	Source
Tree sparrow	Winter seeds	Reduction of seed supply through destruction of food plants by herbicide use, depletion of seed bank in soil, and loss of winter stubbles.	Probably increased mortality of full-grown birds.	Summers-Smith 1996
Linnet	Small weed seeds	Loss of seed supply through destruction of food plants by herbicide use, depletion of seedbank in soil, and loss of winter stubbles.	Probably increased mortality of full-grown birds.	Newton 1986, 1995; O'Connor & Shrub 1986
Cirl bunting	Winter seeds Summer insects	Loss of winter stubble fields, herbicide and insecticide use, destruction of old pastures which provided grasshoppers and other insects.	Increased winter mortality[2], and reduced breeding success.	Evans & Smith 1994; Evans *et al*. 1997
Corn bunting	Winter seeds	Loss of winter stubble fields; herbicide use.	Increased winter loss[3].	Donald & Forrest 1995; Brickle 1999; Donald & Aebischer 1997; Donald & Evans 1994, 1995
Starling	Soil invertebrates Animal feed	Reduction in invertebrate food supply associated with conversion of pasture to autumn-sown cereals and drainage of remaining pasture; redesign of poultry and pig units to exclude birds.	Increased mortality of nestlings and full-grown birds.	Feare 1994; Tianen *et al*. 1989
Skylark	Small weed seeds Arthropods	Reduction of arthropod supply through insecticide use, and of seed supply through herbicide use, and loss of winter stubble.	Inadequate chick production; probably also increased adult mortality.	Schläpfer 1988; Jenny 1990; Wilson *et al*. 1997; Poulsen *et al*. 1998
Lapwing	Soil invertebrates	Land drainage, resulting in drying and hardening of top soil, making invertebrates less available, and giving access to machinery earlier in the year.	Inadequate chick production.	Beintema & Muskens 1987; Peach *et al*. 1994; Shrubb 1990
Grey partridge	Insects for chicks	Destruction of insect food plants by herbicide use; direct destruction of insects by insecticide use.	Inadequate chick survival[2]	Potts 1986; Rands 1985; Potts & Aebischer 1995
Lesser kestrel	Grasshoppers and other insects	Reduction in insect abundance through pesticide use.	Inadequate chick survival.	Hiraldo *et al*. 1996

covering only small spatial scales. Using data from the period 1965 to 1995 from about 200 survey plots across the whole of lowland Britain, BTO examined whether the population change for songbirds between successive years differed between plots with and plots without sparrowhawks and magpies. Although nationally, in lowland farmland (although not in woodlands or uplands), the songbird declines coincided with the recovery of sparrowhawks and magpies, the patterns of population change did not differ between plots with and without predators. The coincidence of timing between declining farmland songbird populations and expanding predators does not imply a causal link between the two processes, and similar coincidences between songbird declines and, for example, the expansion of the collared dove population can also be found.

As yet, however, there have been no studies removing either magpies or sparrowhawks which would experimentally test their effects on song birds as has been undertaken with other predators for gamebirds (*e.g.* Marcström *et al*. 1988; Tapper *et al*. 1996).

In all of the 14 studies that have been undertaken on causes of decline in European farmland birds, none have attributed declines to predation, and all have found that changes of farming practice have primarily been responsible for recorded population changes (Table 6.1). Most such changes in farming practices involved the reduction of food supply for small birds.

6.2 Potential solutions

The Working Group's view is that there is no scientific evidence that sparrowhawks or other birds of prey have had population effects on British songbird populations. In our view the best scientific evidence shows that changes in agricultural practice over recent decades are more likely to have caused the substantial changes we have seen, particularly in farmland birds (Campbell *et al*. 1997). Solutions to these declines are beyond the remit of the Working Group, but are ultimately likely to involve reform of aspects of the Common Agricultural Policy, and consequential agricultural support mechanisms.

Targeted species Action Plans, such as have been developed for skylark, linnet, cirl bunting, reed bunting, red-backed shrike, corn bunting, spotted flycatcher, tree sparrow, bullfinch and turtle dove (Biodiversity Steering Group 1995, 1998), under the UK Biodiversity Action Plan are likely to be helpful. We consider it crucial to maintain monitoring programmes for all the species concerned (principally the BTO/JNCC/RSPB Breeding Bird Survey).

7 Conclusions and recommendations

We have presented our conclusions and recommendations separately for each of the four major issues we have addressed. In each of these sections (7.1-7.5) we have ordered the text in sub-sections with respect to our Terms of Reference.

For the Working Group to recommend doing nothing is not a sensible option. The Group's view is that this would not solve the problem of illegal killing of birds of prey, grouse moor management, pheasant releases and pigeon racing. Accordingly, we recommend a range of actions be undertaken by government, by its agencies and by others, which will positively address the current conflict.

7.1 Population and conservation status

Consider population status of birds of prey

Population status

1 Most UK raptors experienced major historical declines in population size and distribution as a consequence of killing by man in the 19th and early 20th century. White-tailed eagle, marsh harrier, goshawk and osprey, and possibly honey buzzard and Montagu's harrier, were all driven to extinction in Britain and Ireland, whilst red kite and hen harrier were driven to the edge of extinction in Britain earlier this century. Since then, partly as a result of a range of conservation measures (including programmes of re-establishment for red kite and white-tailed eagle), most populations have at least partially recovered, although most have yet to achieve the full extent of their former or potential distributions (Table 2.2). We have reviewed the current population status of birds of prey in the UK and our findings are presented in Table 2.1. In the post-breeding season, peak numbers of birds of prey are greater than these estimates owing to the numbers of fledged young and other non-breeding individuals, but it has not proved possible to obtain reliable estimates for these additional birds. Most of these young birds will die of natural causes during their first years of life.

2 The current population status, trends and absolute numbers of all British birds of prey are, at least, moderately well understood and known. The nature of the information available gives us confidence that, although there are gaps and more data and information would *always* be useful, there is a sound basis for making recommendations to government concerning the conservation and management of British birds of prey.

3 The 1998 population survey of hen harrier indicates that there has been no overall change in the last ten years. The Scottish and Welsh population totals are very similar to those of ten years ago. In other areas there were changes: numbers on Orkney have declined by half to only 34 pairs. This is probably due to food shortages. Numbers have declined in the north and east Highlands whilst increasing in south and west Scotland. Numbers in England, which climbed to 37 territorial females in 1994, have declined by about half since then; numbers in Northern Ireland have increased to 38 pairs, and there has been a small increase on the Isle of Man. Based on these results it is clear that the status of hen harrier remains unfavourable with numbers and distribution significantly constrained.

Legal status

4 As for other birds, all birds of prey in the UK are protected by the 1981 Wildlife and Countryside Act[1] in Great Britain, and in Northern Ireland by the 1985 Wildlife (Northern Ireland) Order, transposing the EEC Directive on the Conservation of Wild Birds. Special conservation measures are required for some, including the establishment of Special Protection Areas (para. 7.2.21 below) for those species which are either listed on Annex 1 of the Directive (honey buzzard, red kite, white-tailed eagle, marsh harrier, hen harrier, Montagu's harrier, golden eagle, osprey, merlin and peregrine) or are migratory (hobby).

5 Eleven of the 16 breeding species are listed as Red Data birds (Table 2.3). In an international context, the UK is of importance for sparrowhawk, kestrel and peregrine as it holds *c.* 10-20% of the total continental European population (west of the Urals) of each species (despite the area of the UK being only 2-3% of the European extent). The UK holds also *c.* 7% of the European golden eagle population, over 4% of tawny owl, 3% of the merlin, 2% of the hen harrier, and 1-2% of the red kite, buzzard and osprey populations (Table 2.3).

6 Ten of the raptor species which occur in the UK are of conservation concern on a European scale (Table 2.3) and six of these – white-tailed eagle, hen harrier, golden eagle, osprey, kestrel and peregrine – are of unfavourable conservation status in Europe.

[1] As amended by The Wildlife and Countryside 1981 (Amendment) Regulations 1995.

Population monitoring provision

7 There is a range of effective population monitoring provision in place, with the methods determined according to the size and dispersion of the different species' populations (Table 2.4). The basis for this monitoring is productive partnerships between the government, the statutory sector and non-governmental organisations.

> 1 We recommend that current programmes of monitoring of birds of prey undertaken by JNCC and the country agencies, RSPB, the Rare Breeding Birds Panel, the Raptor Study Groups and others are maintained at least at existing levels of activity to provide the necessary feedback on the changing status of populations. The productive partnerships between the statutory agencies and non-governmental organisations in monitoring birds of prey should continue to be developed.

8 In order to comply with international requirements, and to underpin the provision of advice on current population status, it is important that monitoring (such as that undertaken by the BTO/JNCC/RSPB Breeding Bird Survey) be maintained, and enhanced for those species poorly covered, or infrequently reported (particularly in England). In this activity, the voluntary sector and especially the Raptor Study Groups have a most important role. The Statutory Conservation Agency/RSPB Annual Breeding Bird Scheme (SCARABBS) programme (section 2.2.3) of proposed national surveys for marsh harrier, hen harrier, golden eagle, red kite, osprey, merlin and peregrine will be especially important in this respect.

9 The collation and dissemination of appropriate data and information is important. The Rare Breeding Birds Panel, in particular, should continue its annual programme of work. The Panel's enhanced collection of data for all Schedule 1 species has the potential to provide an important annual cumulative summary of the status of several populations, subject to substantial annual coverage. In order to fill data gaps, further efforts to improve the submission of data on currently poorly reported species such as honey buzzard would be useful.

> 2 We recommend that the Rare Breeding Birds Panel, as a widely supported, independent body, should be encouraged to develop further its partnerships with the Raptor Study Groups and others, in order to collate and archive relevant data, and to publish appropriate annual summaries of the population status of birds of prey.

10 The Working Group has further noted, and welcomed, the initiative of the Scottish Raptor Study Groups and the Scottish Ornithologists' Club in publishing an annual summary of data (SOC & SRSG 1997, 1998). This is an important complement to other publications.

Illegal killing

11 There has been, and remains widespread illegal killing of birds of prey. During 1990-1997, there have been a total of 720 incidents confirmed, involving at least 834 individual birds of 15 species of raptor (Table 2.5). These confirmed incidents probably reflect only a very small proportion of the total incidents of illegal killing of birds of prey that actually occurred in this period. There is evidence that this activity has limited both the distribution and numbers of red kites, hen harriers, buzzards, golden eagles and peregrines, at a UK scale below levels they would otherwise achieve. The impact of illegal killing (number of incidents relative to national population size) is greatest for hen harriers, followed by red kites, white-tailed eagle and peregrine. Hen harriers are considered at risk of extinction as a breeding species from England, while in both England and Scotland, there is strong evidence of adverse impacts on numbers and productivity associated with illegal killing on grouse moors (section 2.3.4).

12 There is a need for enhanced support for the government Campaign against Illegal Poisoning of Wildlife. Indeed, since most illegal killing uses methods other than poisons (Table 2.5), the campaign should be formally extended to all aspects of illegal killing, thus addressing other methods of illegal raptor killing not currently tackled by the campaign. The Working Group considers that there would be considerable merit in a greater degree of promotion and co-ordination of campaign activities in Scotland. Such co-ordination (via a MAFF-led committee) already exists in England, and another committee has recently been formed in Wales.

> 3 We recommend the development of enhanced inter-agency co-ordination of the implementation of the government Campaign against Illegal Poisoning of Wildlife in Scotland (similar to committees already established in Wales and England) to include other methods of illegal killing of wildlife.
>
> 4 We recommend the continued development of the dissemination of information concerning legal methods of pest control, and the continued strong encouragement to game managers to use legal pest control measures, as well as to the public to respect these measures when encountered.

5 We recommend that the government-led Campaign against Illegal Poisoning of Wildlife be extended to address all aspects of illegal killing, not just those involving poisons.

6 We recommend that the government should amend the 1996 Control of Pesticides Regulations to require those who possess pesticides to be licensed.

13 Enhanced enforcement is needed to reduce illegal killing, and to underpin efforts to encourage game managers and others to pursue alternative legal options of managing game stocks.

14 Recommendations have been made by the Partnership against Wildlife Crime (PAW) relating to a range of enforcement and legislative issues, and we record our general sympathy with these. We note changes to tighten the law, including stronger enforcement measures, as one important element of long-term solutions (section 7.2 below) which include the need for management techniques to help moor managers within the existing legislative framework (section 3.2). The specific PAW recommendations are for government and others to take forward in their detail.

7 We recommend enhanced enforcement of existing legislation to seek to eliminate illegal killing of birds of prey. Such enforcement would underpin efforts to encourage game managers and others to pursue only legal options of enhancing game stocks.

15 Crow cage traps are widely used in the uplands and are subject to the provisions of an open general licence. In view of significant, continued inadvertent misuse, as well as deliberate abuse, these provisions need to be reviewed to eliminate the conditions that allow the capture of non-target species including birds of prey.

8 Continuing deaths of raptors and other non-target birds result from the abuse of crow cage traps. Such deaths are both unnecessary and are likely to reduce public sympathy for the use of this legal method of pest control. Accordingly, we recommend that the appropriate licensing authorities review the provisions of the open general licences covering crow cage traps, in order to seek to eliminate those conditions that might facilitate the abuse of this legal technique of pest control.

Identify gaps in research and future needs, and identify possible sources of funding

16 There is a need for more research into, and monitoring of, the size and extent of the UK hen harrier population. We suggest that national sample surveys be undertaken at intervals of no more than five years until such time as the population is not threatened by illegal killing, and has recovered. The next UK sample survey would thus be in 2003. It would be valuable also to undertake sample surveys of the UK populations of sparrowhawk, buzzard, goshawk and hobby (in order of priority) to obtain more precise information on current population sizes. An investigation into the causes of the current declines in peregrine numbers in parts of the Scottish Highlands would be desirable.

9 We recommend a number of specific enhancements to current research and monitoring activity. These are:

- National sample surveys of hen harrier numbers at not more than five-year intervals until such time as the UK population is not threatened by illegal killing.
- National sample surveys to be undertaken of sparrowhawk, buzzard, goshawk and hobby (in priority order) to obtain better estimates of the current populations and distributions of these species.
- An investigation into the causes of the current declines in peregrine numbers in parts of the Scottish Highlands.

Identify species alleged to be causing problems

17 The following species are associated with particular problems:

Species	Grouse moors	Racing pigeons	Lowland release pens
Hen harrier	Widespread concerns		
Goshawk		Local concerns	Local concerns
Sparrow-hawk		Widespread concerns	Widespread concerns
Buzzard			Widespread concerns
Golden eagle	Local concerns		
Peregrine	Widespread concerns	Widespread concerns	
Tawny owls			Widespread concerns

7.2 Moorland issues

Identify species alleged to be causing problems

1 Hen harrier and peregrine are the two main species that have impacts on red grouse on moorland areas managed for driven grouse shooting.

Other factors that affect red grouse numbers

2 There has been a long-term and widespread decline in the extent, quality and management of heather moorlands throughout Britain. This loss, however, has been substantially less where grouse shooting has been retained.

3 There are significant differences between the situation in Scotland compared to that in England. Over the last 50 years Scottish, but not English grouse bags, have declined. In the last ten years, red grouse densities on monitored moors have not declined in either country. Since 1950, a total of 127 heather moors in Scotland, or 30% of the total, has ceased to be managed for significant sport shooting of red grouse, but only 50 have ceased in England and Wales.

4 In Scotland, grouse moors are more likely to be subject to multiple land-use including heavy sheep grazing. It has been found that in England and Wales, most (77%) grouse moors were grazed below threshold stocking rates, and consequently heather cover was in good condition. Densities of gamekeepers are twice as great in England as in Scotland, and legal predator control (of crows and foxes) is greater in England than in Scotland.

5 Between 1950 and 1990 there was a 32% increase in numbers of sheep in the uplands of England, a 142% increase in Scotland (concentrated in the south and in the lowlands), and a 181% increase in Wales. In Scotland, there has also been an increase in numbers and distribution of red deer – from *c.* 150,000 in the early 1960s to *c.* 300,000 in the early 1990s. There has accordingly been a marked increase in grazing pressure throughout the uplands with negative consequences for quality and extent of heather cover.

6 The red grouse on a small minority of moors are seriously affected by louping ill. This disease is transmitted by sheep ticks, and thus is most prevalent where there are high densities of sheep (therefore exacerbating other habitat-related issues consequent upon overgrazing by sheep). The presence of louping ill may render moors temporarily unsuitable for shooting (although this is easier to manage in England as mountain hares and red deer, which act as additional, alternative hosts for ticks, are absent).

7 There are therefore a variety of factors that point to less intensively managed grouse moors in Scotland, with lower keeper densities and of lower viability than those in England. This must influence priorities in addressing the current situation, with continued emphasis placed on resolving problems in Scotland.

8 Detailed studies at Langholm in south Scotland have estimated, for example, that 48% of heather-dominant vegetation was lost from Langholm moor between 1948 and 1988 (Figure 3.5), mostly at lower altitudes (Figure 3.6). This loss of heather, and consequent increase in grass, was attributed to past heavy grazing by sheep. Such change is mirrored by information from other moorlands, but in general the loss of heather from moors, where there is an interest in grouse management, is much less than elsewhere.

Identify, in particular, the impact of such species [raptors] on gamebirds and moorland management

9 Although grouse bags at Langholm have shown a consistent and significant downward trend of about 2% per annum since 1913, they have also shown six-year fluctuations with the last peak in 1990. The Joint Raptor Study (JRS) concluded that, given that raptor breeding densities were very low before 1990, it is extremely unlikely that raptors were responsible for either the long-term decline or population fluctuations of grouse.

10 After 1990, at Langholm, autumn red grouse stocks were significantly reduced by raptor predation at a time when grouse stocks were low and raptor densities were high. This affected red grouse bags and, subsequent to the study, spring densities at Langholm were reduced and driven grouse shooting was suspended.

11 We note that limitation of red grouse populations through raptor predation will be most likely to occur where raptors breed at high densities and where grouse populations are already at low densities.

Consider statutory and other mechanisms for the resolution of problems

12 The resolution of conflicts will need to be considered through both immediate and longer-lasting measures, as well as through measures that are either local or wide scale in application. This will involve an integration of different approaches, operating at different scales and over varying periods of time.

13 National and European law indicates that, with respect to derogations, the intended purpose of any proposed actions is relevant as to their legality. Relevant also is the population status of raptors and the degree of threat they face. Hence, only a few of the theoretically possible measures to alleviate the problems would be legal without a licence and consequent derogation from the EEC Wild Birds Directive. We consider below only those solutions that would not require derogations.

14 The Group was uncertain as to the legal status of traditionally used nest sites outside the breeding season, particularly those of golden eagle, hen harrier, peregrine and osprey which are regularly re-used. We therefore consider that legal advice should be sought by government and its agencies to determine this issue and clarify any uncertainty.

10 We recommend that government and its agencies should seek legal advice on the status of nests outside the breeding season, and consider whether any modification of domestic legislation is required to protect them.

15 We note the conclusion of Watson (1998) that translocation of hen harriers away from grouse moors is not likely to be an effective solution to conflicts with red grouse. We record our agreement with this conclusion.

16 The EEC Wild Birds Directive allows lethal control as a legal option only in particular circumstances. Any derogation for lethal control would need to consider a range of factors, and would have a very high public profile. Thus, in the current circumstances, where not all other satisfactory solutions to conflicts have been tried, we have ruled out lethal control of raptors.

Options that are legal without derogation under the Wild Birds Directive

Immediate actions

17 For hen harrier, experimental work was undertaken in 1998 and 1999 at Langholm on the extent to which diversionary feeding may reduce the scale and extent of predation on red grouse. Results of these trials were successful, and diversionary feeding is a technique that should be widely promoted as a means of greatly reducing hen harrier predation on red grouse during critical periods.

11 We recommend that every effort be made to support moorland managers through SSSI management agreements, or agri-environment schemes (such as the Countryside Premium Scheme in Scotland). Parts of this package might include payments to defray the costs of diversionary feeding of hen harriers at particular moors managed specifically for red grouse production, and identified as being subject to especially high hen harrier densities in a national context. Diversionary feeding should be linked to the undertaking of longer-term measures to regenerate the extent, and restore the condition, of heather moorland.

12 We recommend the establishment of a scientific trial of the effectiveness of the current practice of diversionary feeding of peregrines which is being undertaken by the establishment of dovecotes on or near grouse moors.

18 The Moorland Working Group (1998) has identified ten principles of good moorland practice which are applicable throughout the UK. There is a need to disseminate these principles and encourage the application of these guidelines.

Habitat actions

19 We consider that the country agencies and the NGOs should work together to develop a bid for EU LIFE funding related to the establishment of a wide-scale demonstration project of the compatibility of good moorland management practices co-existing alongside viable red grouse and bird of prey populations.

13 We recommend the development of an application for EU LIFE funding to establish a wide-scale demonstration project illustrating the compatibility of good moorland management practices co-existing alongside viable red grouse and bird of prey populations. Langholm has been the focus of these topics over recent years, and it may be appropriate to continue to build on previous work there, as well as to broaden the scope to encompass other areas.

20 We welcome the Upland Heathland Habitat Action Plan under the government's initiative on biodiversity, and note the role that this plan will have in halting and reversing the current decline in extent and quality

of heather moorland. We urge wide support for the implementation of this plan.

21 We also note that a network of Special Protection Areas for hen harriers will be classified by government as required under the EEC Wild Birds Directive (EC/79/409). Within these areas, management will seek to ensure the favourable conservation status of hen harriers, and to this end a variety of financial mechanisms are likely to be available to assist the owners and occupiers of these sites.

22 Long-term actions should seek to address the wide-scale and long-term decline in quality (in the absence of targeted management) and quantity of heather moorland throughout the uplands. There is a consequent need for more targeted guidance and incentives for those managing moorlands for the sport shooting of red grouse.

23 In the development of future incentive packages for the uplands, there is a need for greater recognition of, and linkage to, UK biodiversity targets (for both habitats and species). Linkage to local (regional) biodiversity action plans will be useful. Further, there is a need for wildlife benefits to be designed actively into management prescriptions rather than occurring incidentally.

24 We note that there is currently no incentive scheme specifically designed to encourage the restoration of heather moorland from grass-dominated moorland, or specifically targeted at heather moors aside from their agricultural uses. Developing such a scheme to enhance moorlands would be highly desirable in the light of Biodiversity Habitat Action Plan targets (section 3.1.7), and would have material conservation benefits.

14 We recommend the establishment of incentive policies designed to encourage the restoration of heather moorland from grass-dominated moorland, specifically targeted at heather moors aside from their agricultural uses.

25 There is a need for a wider programme of education and public awareness to promote a better understanding of the role and importance of good moorland management practices in conserving the range of species and habitats on moorland.

15 We recommend that a national campaign, supported by the wide range of interested parties, would help focus attention on the desirability of enhanced moorland management. This should be linked to the specific targets of the Upland Heathland Habitat Action Plan.

26 Learning from good practices in incentive provision across the British uplands would be desirable, especially more sharing of the lessons learnt from high-quality schemes (such as English Nature's Wildlife Enhancement Scheme in the Northern Pennines).

27 Whilst a specific incentive scheme targeted at moorland management would be particularly valuable, the refocusing of existing schemes to include additional elements is perhaps a realistic short-term objective that could be more rapidly put in place.

28 In the light of the importance of heather and grouse moors for the upland rural economy (including fragile human communities), as well as for nature conservation and wildlife values, there is a need to restore the quality and extent of heather moorlands. In the future, incentive schemes for upland management, specifically related to biodiversity conservation, should be made conditional upon adequate protection of wildlife on the areas concerned.

29 The idea of a UK 'benchmark' or certification of high standards in habitat and wildlife management has much to commend it. Such standards can be derived from those moors already demonstrating good practice. Estates with such a 'green' or 'eco-badge' of high standards might anticipate attracting environmentally conscious tourists and sportsmen.

16 We recommend the establishment of a register of moorland management projects or estate management demonstrating 'good practice' in the integration and sustainable management of grouse and associated wildlife.

30 The Group has noted *Action for Scotland's moorlands: a statement of intent* signed recently by 14 organisations (Annex 11). This is an important initiative, and such consensus should continue to be developed, especially in the stated objectives of working towards restoring heather cover, to help provide a long term solution to impacts of birds of prey on the red grouse harvest. It is hoped also to seek greater investment in sustainable land management practices in the uplands in order to provide greater employment opportunities in rural areas.

31 The Moorland Working Group was convened by Scottish Natural Heritage to address the issues highlighted by the joint statement *Action for Scottish moorlands* (Annex 11). It has been a most effective means of sharing information on the goals and aspirations of organisations with common concerns in the uplands, as well as technical knowledge and data. It has already produced valuable publications (Moorland Working Group 1998, 1999). We note that, although the Moorland Working Group will continue to carry

the debate forward in Scotland, there are no such mechanisms in England, Wales or Northern Ireland. We consider that the encouragement of dialogue between interested parties in these countries is important.

17 We recommend that the statutory conservation agencies in England, Wales and Northern Ireland consider a means, within these countries, of sharing expertise and facilitating the exchange of information and good practice between those involved in the conservation and management of heather moorland.

32 The lead agency for the co-ordination of actions under the Upland Heathland Habitat Action Plan (section 3.1.7) should be tasked with developing and implementing a strategy of awareness, education and training devised to increase the extent of heather moorland. This strategy should be focused on specific target groups to achieve an impact on all sides of the issues concerned, and taking into account the existing, and potential, contributions of organisations working in this field.

18 We recommend the establishment of a UK-wide education, training and public awareness strategy related ultimately to the reversal of declines in heather moorland extent and quality. The Upland Heathland Habitat Action Plan lead agency should be given the task of co-ordinating this work, with the success of the strategy measured against explicit criteria. It should take account of existing and potential contributions of organisations already working in this field.

Identify gaps in research and future needs, and identify possible sources of funding

33 Of critical importance to the success or failure of modifying habitats to help resolve hen harrier predation of grouse, is an understanding of just how many moors would lose driven grouse shooting if hen harrier numbers increased as they did at Langholm. In particular, this should involve further studies of the relationship in numbers of prey species, such as pipits and voles, to heather cover.

34 There is a need to undertake trials and establish projects that demonstrate a variety of habitat management techniques. Such activity may be valuable, not only in reducing vulnerability of red grouse to raptor predation (through the establishment and maintenance of high density grouse populations), but also in demonstrating the integration of commercial grouse moor management with other objectives for the conservation of biodiversity (as for example urged by the government's Biodiversity Action Plan for upland heathland). Further research would be valuable into possible improvements in heather burning regimes, and the implications of different heather management methods for red grouse production.

35 Experimental diversionary feeding schemes at Langholm in 1998 and 1999 have been undertaken to investigate the degree of reduction of take of red grouse adults and chicks by hen harriers. The results showed significant reductions in mortality of grouse chicks were possible. There is now a need to extend this research through wide-scale projects at a variety of moorlands with differing hen harrier and grouse densities.

36 For peregrines, diversionary feeding (especially the establishment of dovecotes) on or near grouse moors has yet to be attempted under scientifically rigorous conditions, although it has been frequently suggested and, indeed, occurs on several moors. A scientific trial of such diversionary feeding would be valuable research.

37 There would be value in further systematic research to assess the implications of burning regimes, and of sheep grazing, on upland soil erosion and nutrient loss, and the consequences that any findings may have for the sustainability of current upland land-use policies.

19 We recommend further research into the possible long-term declines in moorland soil fertility, and possible associated nutrient declines in food plants postulated to have resulted from burning and grazing regimes.

38 Gamekeepers have an important role in the management of the uplands. The Group noted the successful introduction of the Gamekeeping National/ Scottish Vocational Qualification for gamekeepers, which includes modules on conservation and legal aspects. There remains more that could be undertaken to develop 'in-service training' for gamekeepers, especially with respect to means of reducing conflicts with predators through identified legal means, as well as the further dissemination of good practice management procedures that also benefit biodiversity.

39 The statutory agencies and other organisations have produced some guidance on best practice management for moorlands. As noted in the Upland Heathland Habitat Action Plan, there is scope to update and expand such guidance, and to disseminate it jointly and widely to moorland managers. This might refer appropriately to: methods of legal pest control; conflict resolution with raptors; achievement of biodiversity objectives in the uplands; muirburn practices; and location of demonstration moorlands.

7.3 Pigeon issues

Identify species alleged to be causing problems

1 The sparrowhawk and peregrine are the two species of bird of prey that most frequently interact with racing pigeons. Pigeons also occasionally interact with goshawks (Table 4.1).

Identify, in particular, the impact of such species [raptors] on racing pigeons

2 Evidence of the scale and circumstances of losses to raptors is beginning to emerge. The DETR commissioned research project, undertaken by the Hawk and Owl Trust (HOT), has provided further useful evidence. This study has estimated that peregrines take 3.5% and sparrowhawks take less than 4% of the UK racing pigeon population annually. Such knowledge is essential to the development of a strategy to resolve problems.

3 Although it is estimated that around 7.5% (HOT) and 12.5% (RPRA) of racing pigeons are lost to all raptors per annum in the UK, overall losses to all causes are about 52%. This is similar to natural mortality rates of wood pigeon populations. We note that failure to home, or straying, appears to be the most significant underlying reason for this high level of loss.

Identify gaps in research and future needs, and identify possible sources of funding

4 The findings of the Group to date have identified a number of avenues of potential research (section 4.2) which may help limit predation and/or enhance return rates of racing pigeons to their lofts. There is now a need to undertake pilot trials to test the effectiveness or otherwise of these proposals, and the Group commends this course of action to pigeon racing associations.

5 There are unexploited opportunities of co-operation with universities and other higher education institutes in taking forward such trials. We note current discussions between RSPB, SHU and RPRA concerning the development of a scientific programme to test deterrents around lofts, and whilst racing and training. The Group hopes such a collaborative programme can be agreed in the near future since this might act as a catalyst for a variety of studies.

Consider statutory and other mechanisms for the resolution of problems

6 The legal opinion of DETR and MAFF is that racing pigeons are not defined as agricultural 'livestock' under the terms of either the 1981 Wildlife & Countryside Act for domestic purposes, or for the purpose of implementation of the Wild Birds Directive. Therefore, licences cannot be given for the taking or killing of birds of prey that might be killing or damaging racing pigeons.

20 We recommend that scientific studies be undertaken on the range of possible means of reducing predation on racing pigeons. Collaboration to this effect by the racing pigeon community with academic institutions and, where appropriate, internationally, would help derive effective long-term measures to reduce the scale of losses currently experienced both at lofts, and during racing or training.

21 We recommend that priority attention should be given to understanding the causes of straying during racing, especially for young birds. Minimising straying is likely to be the single, most effective way of enhancing pigeon return rates. We have made a number of suggestions that might usefully be followed up (although not all of these are likely to be universally applicable, and an integration of measures will be necessary).

22 We recommend that consideration be given to delaying the start of the 'old bird' racing season in order to avoid the current coincidence with the start of the peregrine's breeding season.

23 We recommend that consideration be given to re-organising race routes, especially for young bird racing, in an attempt to establish 'flight corridors' and reduce the current complexity of north/south and east/west 'crossovers'.

7.4 Birds of prey in the lowlands

Identify species alleged to be causing problems

1 Several birds of prey have been identified as predating on lowland gamebirds (mainly pheasants but also partridges), in particular, sparrowhawk, buzzard, tawny owl and goshawk.

Identify, in particular, the impact of such species on game birds

2 It is estimated that up to 20 million pheasants are reared and released each year. In this context, losses of

pheasants and partridges to raptor predation are minimal. There are, however, widespread concerns over losses at individual release pens which studies have shown to range from 0.5-10%. Locally there are instances of considerable impacts, indicating losses of up to 46% in some pheasant release pens, and 70% relating to grey partridge.

3 The focus of the concerns is the pheasant release pen. There is a need to address the real and perceived raptor problems in and around pheasant release pens. Traditional non-lethal preventative measures continue to be used by many (68%) gamekeepers who experience raptor problems, although others continue to take no protective measures. These measures have not been subject to objective assessment to determine the extent to which they consistently and reliably reduce problems experienced from raptors to acceptable levels. Such an assessment is needed to allow advice to be formulated.

Identify gaps in research and future needs, and identify possible sources of funding

4 There is a need, therefore, to address the real and perceived raptor problems in and around pheasant release pens. Research into means of reducing impacts of birds of prey at pheasant release pens was published in 1976. The various methods advocated have, however, not been subject to objective assessment to determine the extent to which they consistently and reliably reduce problems experienced from raptors to acceptable levels. Such an assessment is needed to allow clear advice to be given to encourage game managers to use non-lethal preventative measures. At present, whilst many, but not all gamekeepers, use traditional non-lethal preventative measures, many lowland game managers are no longer aware of the earlier research or lack confidence in the methods it advocates.

5 Accordingly new research is underway (section 5.2.2; Annex 8) to take forward understanding of bird of prey impacts at pheasant release pens. This work examines means of mitigation, and ways to improve the effectiveness of management techniques.

Consider statutory and other mechanisms for the resolution of problems

6 There is a need to ensure that this research is completed and its conclusions widely promulgated through the publication of updated 'best practice guidance' – perhaps jointly produced by a range of interested organisations to ensure wide dissemination.

24 We recommend that the results of current research into predation impacts at lowland pheasant release pens, and derived information on the effectiveness of different deterrents to predation, be widely disseminated throughout the lowland game shooting community.

7.5 Raptors and songbirds

1 It has been suggested that the recovery of populations of some birds of prey has caused declines in formerly common farmland birds. Although the declines of many songbirds have coincided with the recovery of sparrowhawks, patterns of songbird population changes have not differed between monitoring plots with and without sparrowhawks. On the basis of a range of evidence presented to the Working Group, we conclude that it has primarily been changes of agricultural practices, rather than recoveries of lowland raptor populations, that have been responsible for the widespread declines in many formerly common farmland birds.

25 We recommend the maintenance of monitoring programmes for all the species concerned (principally the BTO/JNCC/RSPB Breeding Bird Survey).

8 References

Anderson, P & Yalden, DW 1981 Increased sheep numbers and loss of heather moorland in the Peak District, England. *Biological Conservation 20*: 193-213.

Arvill, R 1967 *Man and environment. Crisis and the strategy of choice*. London, Penguin Books. 384 pp.

Baines, D 1996 The implications of grazing and predator management on the habitats and breeding success of black grouse *Tetrao tetrix*. *Journal of Applied Ecology 33*: 54-62.

Balharry, EA & Macdonald, DW 1996 A cost effective method for protecting livestock against marten predation. *Scottish Natural Heritage Research, Survey and Monitoring Report No. 47*. 32 pp.

Bardgett, RD & Marsden, JH 1992 *Heather condition and management in England and Wales*. Peterborough, English Nature. 51 pp.

Bardgett, RD, Marsden JH & Howard, DC 1995 The extent and condition of heather on moorlands in the uplands of England and Wales. *Biological Conservation 71*: 155-161.

Barnes, RFW 1987 Long-term declines of red grouse in Scotland. *Journal of Applied Ecology 24*: 735-741.

Barr, CJ, Bunce, RGH, Clarke, RT, Fuller, RM, Furse, MT, Gillespie, MK, Groom, GB, Hallam, CJ, Hornung, M, Howard, DC & Ness, MJ 1993 *Countryside Survey 1990. Main report*. Department of the Environment. 174 pp.

Barton, AF & Robertson, PA 1997 *Land cover change in the Scottish uplands, 1945-1990, in relation to grouse shooting interests*. Fordingbridge, Game Conservancy Trust. Unpublished report.

Batten, LA, Bibby, CJ, Clement, P, Elliott, GD & Porter, RF 1990 *Red Data birds in Britain*. London, T & AD Poyser.

Baxter, EV & Rintoul, LJ 1953 *The birds of Scotland. Their history, distribution and migration*. Edinburgh & London, Oliver and Boyd. (2 volumes.)

Beintema, AJ & Muskens, GJDM 1987 Nesting success of birds breeding in Dutch agricultural grasslands. *Journal of Applied Ecology 24*: 743-758.

Bibby, C & Etheridge, B 1993 Status of the hen harrier *Circus cyaneus* in Scotland in 1988-89. Bird Study 40: 1-11.

Bibby, CJ & Nattrass, M 1986. Breeding status of the merlin in Britain. *British Birds 79*: 170-185.

Bibby, C, Robinson, P & Bland, E 1990. The impact of egg collecting on scarce breeding birds. *RSPB Conservation Review 4*: 22-25.

Biodiversity Steering Group 1995 *Biodiversity: the UK Steering Group. Volume 2: Action Plans*. London, HMSO. 103 pp.

Biodiversity Steering Group 1998. *UK Biodiversity Group. Tranche 2: Action Plans. Volume 1 – vertebrates and vascular plants*. London, HMSO. 324 pp.

Brickle, NW 1999 *The effects of agricultural intensification on the decline of the corn bunting* Milaria calandra. DPhil thesis, University of Sussex.

Brown, AF & Stillman, RA 1993 Bird-habitat associations in the eastern Highlands of Scotland. *Journal of Applied Ecology 30*: 31-42.

Brown, AF, & Bainbridge, IP 1995 Grouse moors and upland breeding birds. *In: Heaths and moorland: cultural landscapes*, ed. by DBA Thompson, AJ Hester and MB Usher, 51-66. Edinburgh, HMSO.

Brown, L 1976 *British birds of prey*. Glasgow, Collins. 124 pp.

Brown, P 1964 *Birds of prey*. London, Andre Deutsch. 124 pp.

British Trust for Ornithology, Hawk and Owl Trust, National Trust, Royal Society for the Protection of Birds, Scottish Raptor Study Groups, Wales Raptor Study Groups & the Wildlife Trusts 1995. *Birds of prey in the UK: a review and implications for future policies*. Report to DETR/JNCC Raptor Working Group. 72 pp.

Bunce, RGH, Barr, CJ & Fuller, RM 1992 Integration of methods for detecting land use change, with special reference to Countryside Survey 1990. *In: Land use change: the causes and consequences*, ed. by MC Whitby. *ITE Symposium No. 27*: 69-78. London, HMSO.

Campbell, LH, Avery, MI, Donald, P, Evans, AD, Green, RE & Wilson, JD 1997 *A review of the indirect effects of pesticides on birds*. Peterborough, Joint Nature Conservation Committee. 148 pp. (JNCC Report, No. 227.)

Carroll, J & Robertson, P 1997 *Integrating pheasant management and woodland conservation*. Fordingbridge/ Peterborough, Game Conservancy Trust/English Nature.

Carson, R 1965 *Silent spring*. London, Penguin Books.

CEAS Consultants 1993 *The economy of landscape and nature conservation in England and Wales*. Unpublished report to Countryside Council for Wales, Countryside Commission and English Nature.

Cobham Resource Consultants 1997 *Countryside sports; their economic and conservation significance*. The Standing Conference on Countryside Sports.

Crabtree, JR, Leat, PMK, Santarossa, J, Thomson, KJ & Lee, KM 1992 *The Economic Contribution and Potential of Nature Conservation. Proceedings of a Conference, 'People, Economies and Nature Conservation', UCL, London*.

Crick, HQP & Ratcliffe, DA 1995 The peregrine *Falco peregrinus* breeding population of the United Kingdom in 1991. *Bird Study 42*: 1-19.

Crick, HQP, Baillie, SR, Balmer, DE, Bashford, RI, Beaven, LP, Dudley, C, Glue, DE, Gregory, RD, Marchant, JH, Peach, WJ & Wilson, AM 1998 *Breeding birds in the wider countryside; their conservation status (1972-1996)*. Thetford, British Trust for Ornithology. (BTO Research Report, No. 198.)

Davis, PE 1993 The red kite in Wales: setting the record straight. *British Birds 86*: 295-298.

Davis, PE & Newton, I 1981 Population and breeding of red kites in Wales over a 30-year period. *Journal of Animal Ecology 50*: 759-772.

Dennis, RH, Ellis, PM, Broad, RA & Langslow, DR 1984 The status of the golden eagle in Britain. *British Birds 77*: 592-607.

Dick, TD & Stronach, A 1998 *The use, abuse and misuse of crow cage traps in Scotland*. Report on behalf of Scottish Raptor Study Groups and RSPB to SOAEFD, Edinburgh. 14 pp.

Dick, TD & Stronach, A 1999 The use, abuse and misuse of crow cage traps in Scotland: a report on behalf of the Scottish Raptor Study Groups and RSPB. *Scottish Birds 20*: 6-13.

Donald, PF, & Aebischer, NJ eds. 1997 *The ecology and conservation of corn buntings* Milaria calandra. Peterborough, Joint Nature Conservation Committee. (UK Nature Conservation, No. 13.)

Donald, PF & Evans, AD 1994 Habitat selection by corn buntings *Milaria calandra* in winter. *Bird Study 41*: 199-210.

Donald, PF & Evans, AD 1995. Habitat selection and population size of corn buntings *Milaria calandra* breeding in Britain in 1993. *Bird Study 42*: 190-204.

Donald, PF & Forrest, C 1995 The effects of agricultural change on population size of corn buntings *Miliaria calandra* on individual farms. *Bird Study 42*: 205-215.

Egdell, JM 1995 *The economics of upland grouse shooting: implications for wildlife*. Sandy, Royal Society for the Protection of Birds. Internal RSPB report. 66 pp.

Elliott, GD & Avery, MI 1991 A review of reports of buzzard persecution 1975-1989. *Bird Study 38*: 52-56.

English Nature 1996 *Land management for upland birds*. Peterborough, English Nature. 8 pp.

Etheridge, B, Summers, RW & Green, RE 1997 The effects of illegal killing and destruction of nests by humans on the population dynamics of the hen harrier *Circus cyaneus* in Scotland. *Journal of Applied Ecology 34*: 1081-1105.

Evans, AD & Smith, KW 1994 Habitat selection of cirl buntings *Emberiza cirlus* wintering in Britain. *Bird Study 41*: 81-87.

Evans, AD, Smith, KW, Buckingham, DL & Evans, J 1997 Seasonal variation in breeding performance and nestling diet of cirl buntings *Emberiza cirlus* in England. *Bird Study 44*: 66-79.

Evans, IM & Pienkowski, MW 1991 World status of the red kite: a background to the experimental reintroduction to England and Scotland. *British Birds 84*: 171-187.

Evans, IM, Dennis, RH, Orr-Ewing, DC, Kjellén, N, Andersson, P-O, Sylvén, M, Senosiain, A & Compaired Carbo, F 1997 The re-establishment of red kite breeding populations in Scotland and England. *British Birds 90*: 123-138.

Evans, IM, Summers, RW, O'Toole, L, Orr-Ewing, DC, Evans, R, Snell, N, & Smith, J 1999 Evaluating the success of translocating red kites *Milvus milvus* to the UK. *Bird Study 46*: 129-144.

Feare, CJ 1994 Changes in numbers of common starlings and farming practice in Lincolnshire. *British Birds 87*: 200-204.

Fuller, RJ & Gough, SJ 1999 Changes in sheep numbers in Britain: implications for bird populations. *Biological Conservation 91*: 73-89.

Game Conservancy Trust 1998 *Hen harriers on grouse moors. A response by the Game Conservancy Trust to 'A future for grouse moors: a call to action' published by a partnership of conservation NGOs*. Unpublished submission to DETR/JNCC Raptor Working Group.

Gibbons, DW, Reid, JB & Chapman, RA 1993 *The new atlas of breeding birds in Britain and Ireland*: 1988-1991. London, T & AD Poyser. 520 pp.

Gibbons, DW, Gates, S, Green, RE, Fuller, RJ & Fuller, RM 1995 Buzzards *Buteo buteo* and ravens *Corvus corax* in the uplands of Britain: limits to distribution and abundance. *Ibis 137*: S75-S84.

Gill, EL, Cotterill, JV, Cowan, DP, Grey, CB, Gurney, JE, Moore, NP, Nadian, AK & Watkins, RW 1999 All in the worst possible taste: chemical repellents in vertebrate pest management. *In: Advances in vertebrate pest management*, ed. by DP Cowan, DP and CJ Feare, 283 295. Fürth, Filander Verlag. 413 pp.

Grant, MC, Orsman, C, Easton, J, Lodge, C, Smith, M, Thompson, G, Rodwell, S & Moore, N 1999 Breeding success and causes of breeding failure of curlew *Numenius phaeopus* in Northern Ireland. *Journal of Applied Ecology 36*: 59-74.

Gray, R 1871 *Birds of the west of Scotland, including the Outer Hebrides*. Murray, Scotland. 520 pp.

Green, RE 1988 Stone-curlew conservation. *RSPB Conservation Review 2*: 30-33.

Green, RE 1995 The decline of the corncrake *Crex crex* in Britain continues. *Bird Study 42*: 66-75.

Green, RE 1996 The status of the golden eagle in Britain in 1992. *Bird Study 43*: 20-27.

Green, RE & Etheridge, B 1999 Breeding success of the hen harrier *Circus cyaneus* in relation to the distribution of grouse moors and the red fox *Vulpes vulpes. Journal of Applied Ecology 36*: 472-483.

Green, RE & Stowe, TJ 1993 The decline of the corncrake in Britain and Ireland in relation to habitat change. *Journal of Applied Ecology 30*: 689-695.

Green, RE, Pienkowski, MW & Love, JA 1997 Long term viability of the re-introduced population of the white tailed eagle *Haliaeetus albicilla* in Scotland. *Journal of Applied Ecology 33*: 357-368.

Gregory, RD & Marchant, JH 1996 Population trends of jays, magpies, jackdaws and carrion crows in the United Kingdom. *Bird Study 43*: 28-37.

Gregory, RD, Bashford, RI, Balmer, DE, Marchant, JH, Wilson, AM & Baillie, SR 1997 *The breeding bird survey 1995-1996*. Thetford, BTO/JNCC/RSPB. 16 pp.

Gregory, RD, Bashford, RI, Beaven, LP, Marchant, JH, Wilson, AM & Baillie, SR 1998 *The breeding bird survey 1996-1997*. Thetford, BTO/JNCC/RSPB. 16 pp.

Hagemeijer, EJM & Blair, MJ, eds. 1997 *The EBCC atlas of European breeding birds: their distribution and abundance*. London, T & AD Poyser. 903 pp.

Hancock, M, Baines, D, Gibbons, D, Etheridge, B & Shepherd, M 1999 The status of male black grouse *Tetrao tetrix* in Britain in 1995-96. *Bird Study 46*: 1-15.

Harradine, J, Reynolds, N, & Laws, T 1997 *Raptors and gamebirds – a survey of game managers affected by raptors*. Marford Mill, British Association for Shooting and Conservation. 39 pp.

Hewson, R 1984 Changes in the numbers of foxes (*Vulpes vulpes*) in Scotland. *Journal of Zoology, London 204*: 561 569.

Hinsley, SA & Redpath, S 1996 *Impacts of raptor predation on red grouse, homing pigeons and songbirds in Britain*. 74 pp. Unpublished report to JNCC/SOAEFD.

Hiraldo, F, Negro, JH, Donazar, JA & Gaona, P 1996 A demographic model for a population of the endangered Lesser kestrel in southern Spain. *Journal of Applied Ecology 33*: 1085-1093.

HMSO 1994 *Biodiversity: the UK Action Plan*. London, HMSO.

Holling, M & McGarry, O 1994 A review of the changing status of buzzard in the Borders. *Borders Bird Report 1992 14*: 76-82.

Holloway, S 1996 *The historical atlas of breeding birds in Britain and Ireland, 1875-1900*. London, T & AD Poyser. 476 pp.

Holmes, J, Walker, D, Davies, P & Carter, I 2000 *The illegal persecution of raptors in England*. Peterborough, English Nature. (English Nature Research Report.)

Hudson, PJ 1986 *Red grouse: the biology and management of a wild gamebird*. Fordingbridge, Game Conservancy Trust. 249 pp.

Hudson, PJ 1992 *Grouse in space and time: the population biology of a managed gamebird*. Fordingbridge, Game Conservancy Trust. 224 pp.

Hunting Surveys 1986 *Monitoring landscape change, volume 1*. Main report. Borehamwood, Hunting Surveys.

Independent Northern Consultants 1995 *Assessment of the direct employment impact of environmental activity in the Highlands and Islands.* Report for Highlands and Islands Enterprise and Scottish Natural Heritage.

IUCN – The World Conservation Union, Species Survival Commission, Re-introduction Specialist Group 1995 *Guidelines for re-introductions*. Gland, Switzerland, IUCN. 7 pp.

Jenkins, D, Watson, A & Miller, G 1963 Population studies on red grouse in northeast Scotland. *Journal of Animal Ecology 32*: 317-376.

Jenkins, D, Watson, A & Miller, G 1964 Predation and red grouse populations. *Journal of Applied Ecology 1*: 183-195.

Jenny, M 1990 Nahrungsökologie der Feldlerche Alauda arvensis in einer intensiv genutzten Agrarlandschaft des schweizeruschen Mittelands. *Der Ornithologische Beobachter 87*: 31-53.

Jerram, R & Drewitt, A 1998 *Assessing vegetation condition in the English uplands*. Peterborough, English Nature. 36 pp. (English Nature Research Report, No. 264.)

Joint Nature Conservation Committee 1996. *Birds of Conservation Importance*. Press Release, 31 May 1996. JNCC, Peterborough.

Kenward, RE, Marquiss, M & Newton, I 1981 What happens to goshawks trained for falconry? *Journal of Wildlife Management 145*: 803-806.

Lloyd, DEB 1976a *Avian predation of reared pheasants*. Unpublished report for the British Field Sports Society, Game Conservancy, Royal Society for the Protection of Birds and the Wildfowlers Association of Great Britain and Ireland. 84 pp.

Lloyd, DEB 1976b *The predation of pheasants in release pens from birds of prey*. British Field Sports Society, The Game Conservancy, Royal Society for the Protection of Birds and the Wildfowlers Association of Great Britain and Ireland. 12 pp.

Lovat, Lord 1911 *The grouse in health and disease*. London, Committee of Inquiry on Grouse Disease. (2 volumes.)

Love, JA 1988 *The reintroduction of the white-tailed sea eagle to Scotland: 1975-1987*. Peterborough, Nature Conservancy Council. 48 pp. (Research & survey in nature conservation, No.12.)

Love, J 1989 *Eagles*. London, Whittet Books. 128 pp.

Lovegrove, R 1994 *Birds in Wales*. London, T & AD Poyser.

Lovegrove, R, Elliott, G & Smith, K 1990 The red kite in Britain. *RSPB Conservation Review 4*: 15-21.

Lovegrove, R, Shrubb, M & Williams, I 1995 *Silent fields. Gwlad Tawel. The current status of farmland birds in Wales*. Sandy, Royal Society for the Protection of Birds. 33 pp.

MacKay Consultants 1997 *Jobs and the natural heritage in Scotland*. Inverness, MacKay Consultants. Report for Scottish Natural Heritage.

Mackey, EM, Shewry, M, & Tudor, GJ 1998 *Land cover change: Scotland from the 1940s to the 1980s*. Edinburgh, The Stationery Office. 263 pp.

MAFF, SOAFD, DANI & WOAD 1993 *The digest of agricultural census statistics, United Kingdom 1992*. London, HMSO.

Malcolm, G & Maxwell, A 1910 *Grouse and grouse moors*. London, Adam and Charles Black. 286 pp.

Marchant, JH, Hudson, R, Carter, SP & Whittington, P 1990 *Population trends in British breeding birds*. Tring/Peterborough, BTO/NCC. 300 pp.

Marchant, JR & Watkins, W 1897 *Wild Birds Protection Acts, 1880-1896*. 2nd ed. London, RH Porter. 174 pp.

Marcström, V, Engren, E & Kenward, RE 1988 The impact of predation on boreal tetraonids during vole cycles – an experimental study. *Journal of Animal Ecology 57*: 859-872.

Marquiss, M & Newton, I 1982 The goshawk in Britain. *British Birds 75*: 243-260.

McGilvray, J 1995 *An economic study of grouse moors*. Glasgow, University of Strathclyde. 36 pp.

McGilvray, J & Perman, R 1991. *Grouse shooting in Scotland: an analysis of its importance to the economy and environment*. Report of the Game Conservancy Trust's Grouse Research Project. 89 pp.

McGilvray, J, McRoy, E, Penman, R & Stewart, WJ 1990 *The economic impact of sporting shooting in Scotland*. Glasgow, Fraser of Allander Institute, University of Strathclyde. Report to BASC/Scottish Development Department.

McVean, DN & Lockie, J 1969 *Ecology and land-use in upland Scotland*. Edinburgh, Edinburgh University Press. 134 pp.

McVean, DN & Ratcliffe, DA 1962 *Plant communities of the Scottish highlands: a study of Scottish mountain, moorland and forest vegetation*. London, HMSO. 445 pp.

Mearns, B & Mearns, R 1998 *The bird collectors*. London, Academic Press. 472 pp.

Meek, ER, Rebecca, GW, Ribbands, B & Fairclough, K 1998 Orkney hen harriers: a major population decline in the absence of persecution. *Scottish Birds 19*: 290-298.

Miller, GR, Watson, A & Jenkins, D 1970 Responses of red grouse populations to experimental improvement in their food. *In: Animal populations in relation to their food resources*, ed. by A Watson, 323-325. Oxford, Blackwell.

Moore, NW 1957 The past and present status of the buzzard in the British Isles. *British Birds 50*: 173-197.

Moore, NW 1987 *The bird of time. The science and politics of nature conservation – a personal account*. Cambridge, Cambridge University Press. 290 pp.

Moorland Working Group 1998 *Good practice for grouse moor management*. Battleby, Scottish Natural Heritage. 24 pp.

Moorland Working Group 1999 *Substitute feeding of hen harriers on grouse moors*. Battleby, Scottish Natural Heritage. 20 pp.

Morton, K, O'Toole, L & Orr-Ewing, D 1998 *Red kites poisoned in Scotland 1997 and 1998. An examination of the circumstances and significance of the illegal poisoning of eight red kites in Scotland in 1997 and 1998*. 24 pp. Confidential report from RSPB commissioned by DETR/JNCC Raptor Working Group.

Murton, RK 1965 *The woodpigeon*. London, Collins (New Naturalist Series). 256 pp.

Musgrove, A 1996 *Peregrines and pigeons: investigations into a raptor-human conflict*. PhD thesis, University of Bristol.

Musgrove, A 1998 Peregrines and pigeons (again!). *BTO News 214*: 11.

Nature Conservancy Council 1986 *Nature conservation and afforestation in Britain*. Peterborough, Nature Conservancy Council. 108 pp.

Newton, I 1979 *Population ecology of raptors*. Berkhampstead, T & AD Poyser. 399 pp.

Newton, I 1986 *The sparrowhawk*. T & AD Poyser, Carlton. 396 pp.

Newton, I 1993 Predation and limitation of bird numbers. *Current Ornithology 11*: 143-194.

Newton, I 1994 Current population levels of diurnal raptors in Britain. *The Raptor 21*: 17-21.

Newton, I 1995 The contribution of recent research on birds to ecological understanding. *Journal of Applied Ecology 64*: 675-696.

Newton, I 1998 *Population limitation in birds*. London, Academic Press. 597 pp.

Newton, I, Dale, L & Rothery, P 1997 Apparent lack of impact of sparrowhawks on the breeding densities of some woodland songbirds. *Bird Study 44*: 129-135.

Newton, I, Wyllie, I & Dale, L 1999 Trends in the numbers and mortality patterns of sparrowhawks and kestrels in Britain, as revealed by carcass analyses. *Journal of Zoology 24*: 139-147.

Noble, D, Bashford, RI, Marchant, JH, Baillie, SR & Gregory, RD 1999 *The breeding bird survey – 1998*. Thetford, BTO/JNCC/RSPB. 16 pp.

Norris, CA 1945 Summary of a report on the distribution and status of the corncrake (*Crex crex*). *British Birds 38*: 142-148, 162-168.

O'Connor, RJ & Shrubb, M 1986 *Farming and birds*. Cambridge, Cambridge University Press. 290 pp.

Ogilvie, MA & the Rare Breeding Birds Panel 1996 Rare breeding birds in the United Kingdom in 1994. *British Birds 89*: 387-417.

Ogilvie, MA and the Rare Breeding Birds Panel 1999a Rare breeding birds in the United Kingdom in 1996. *British Birds 92*: 120-154.

Ogilvie, MA & the Rare Breeding Birds Panel 1999b Rare breeding birds in the United Kingdom in 1997. *British Birds 92*: 389-428.

Parr, R 1992 The decline to extinction of a population of golden plover in north-east Scotland. *Ornis Scandinavica 23*: 152-158.

Parr, R 1993 Nest predation and numbers of golden plovers *Pluvialis apricaria* and other moorland waders. *Bird Study 40*: 223-231.

Peach, WJ, Thompson, PS & Coulson, JC 1994 Annual and long-term variation in the survival rates of British lapwings *Vanellus vanellus*. *Journal of Applied Ecology 63*: 60-70.

Petty, SJ 1992 *Ecology of the tawny owl* Strix aluco *in the spruce forests of Northumberland and Argyll*. PhD thesis, The Open University, Milton Keynes.

Petty, SJ 1996 History of the northern goshawk *Accipiter gentilis* in Britain. *In: The introduction and naturalisation of birds*, ed. by JS Holmes and JR Simons, 95-102. London, HMSO.

Picozzi, N 1978 Dispersion, breeding and prey of the hen harrier *Circus cyaneus* in Glen Dye, Kincardineshire. *Ibis 120*: 489-509.

Picozzi, N & Weir, D 1976 Dispersal and causes of death of buzzards. *British Birds 69*: 193-201.

Pitcairn, CER, Fowler, D & Grace, J 1995 Deposition of fixed atmospheric nitrogen and foliar nitrogen content of bryophytes and *Calluna vulgaris* (L.) Hull. *Environmental Pollution 88*: 193-205.

Potts, GR 1986 *The partridge: pesticides, predation and conservation*. London, Collins. 274 pp.

Potts, GR 1990 Numbers, harvest, status and management recommendations for game species in the UK. *The Game Conservancy Annual Review 33*: 30.

Potts, GR 1998 Global dispersion of nesting hen harriers *Circus cyaneus*; implications for grouse moors in the UK. *Ibis 140*: 76-88.

Potts, GR & Aebischer, NJ 1995 Population dynamics of the grey partridge *Perdix perdix* 1793-1993: monitoring, modelling and management. *Ibis 137*: S29-S37.

Poulsen, JG, Sotherton, NW, & Ebischer, NJ 1998. Comparative nesting and feeding ecology of skylarks *Alauda arvensis* on arable farmland in southern England with special reference to set-aside. *Journal of Applied Ecology 35*: 131-147.

Price, AJ 1994 *A study of captive rearing of red grouse* Lagopus lagopus scoticus. Aberdeen, University of Aberdeen.

Rands, MRW 1985 Pesticide use on cereals and the survival of partridge chicks: a field experiment. *Journal of Applied Ecology 22*: 49-54.

Rare Breeding Birds Panel 1999 Honey-buzzards in Britain: an announcement by the Rare Breeding Birds Panel. *British Birds 92*: 345-346.

Ratcliffe, DA 1972 The peregrine population of Great Britain in 1971. *Bird Study 19*: 117-156.

Ratcliffe, DA 1984 The peregrine breeding population of the United Kingdom in 1981. *Bird Study 31*: 1-18.

Ratcliffe, DA 1993 *The peregrine falcon*. 2nd ed. London, T & AD Poyser. 454 pp.

Rayment, M 1997 *Working with nature in Britain. Case studies of nature conservation, employment and local economies*. Sandy, Royal Society for the Protection of Birds.

Rebecca, G & Bainbridge, IP 1998 The breeding status of Merlin *Falco columbarius* in Britain in 1993-94. *Bird Study 45*: 172-187.

Redpath, SM 1991 The impact of hen harriers on red grouse breeding success. *Journal of Applied Ecology 28*: 659-671.

Redpath, SM 1998 *Management trial to reduce hen harrier predation on red grouse at Langholm 1998: the effects of providing hen harriers with supplementary food*. ITE contract report to SNH (Contract BAT/98/99/015). 35 pp.

Redpath, SM & Thirgood, SJ 1997 *Birds of prey and red grouse*. London, The Stationery Office. 148 pp.

Redpath, SM, Thirgood, SJ, Leckie, FM & Lock, KA 1999 *Management trial to reduce hen harrier predation on red grouse at Langholm: the effects of providing hen harriers with supplementary food*. ITE/GCT draft report to SNH.

Reynolds, JC 1999 The potential for exploiting conditioned taste aversion (CTA) in wildlife management. *In: Advances in vertebrate pest management*, ed. by DP Cowan and CJ Feare, 267-282. Fürth, Filander Verlag. 413 pp.

Reynolds, J & Tapper, S 1994 Are foxes on the increase? *The Game Conservancy Review of 1999 25*: 94-96.

Roberts, JL 1998 Wintering of hen harriers *Circus cyaneus* on a moor in NE Wales: sex ratios, seasonality and possible links with the numbers of red grouse *Lagopus l. scoticus*. *Welsh Birds 2*: 46-53.

Roberts, SJ, Lewis, JMS & Williams, IT 1999 Breeding European honey-buzzards in Britain. *British Birds 92*: 326-345.

Robertson, PA 1996 Naturalised introduced gamebirds in Britain. *In: The introduction and naturalisation of birds*, ed. by JS Holmes and JR Simons, 63-69. London, HMSO.

Robertson, PA, Woodburn, MIA, Tapper, SC & Stoate, C 1989 *Estimating game densities in Britain from land-use maps*. Game Conservancy Trust report to the Institute of Terrestrial Ecology.

RPRA (Royal Pigeon Racing Association) 1996 *Pigeon racing*. Cheltenham, Royal Pigeon Racing Association. Results of questionnaire survey. 6 pp

RSPB 1995 *Bird of prey persecution in Scotland in 1994*. Edinburgh, Royal Society for the Protection of Birds. 16 pp.

RSPB 1996 *Persecution: a review of bird of prey persecution in Scotland 1996*. Edinburgh, Royal Society for the Protection of Birds.

RSPB 1997 *Persecution: a review of bird of prey persecution in Scotland in 1997*. Edinburgh, Royal Society for the Protection of Birds.

RSPB 1999a *Persecution: a review of bird of prey persecution in Scotland in 1998*. Edinburgh, Royal Society for the Protection of Birds. 22 pp.

RSPB 1999b *Birdcrime '98. Offences against wild bird legislation 1998*. Royal Society for the Protection of Birds. 48 pp.

Royal Society for the Protection of Birds & Nature Conservancy Council 1991a *Death by design. The persecution of birds of prey and owls in the UK 1979-1989*. Sandy/Peterborough, Royal Society for the Protection of Birds/Nature Conservancy Council. 28 pp.

Royal Society for the Protection of Birds & Nature Conservancy Council 1991b *Persecution. Birds of prey and owls killed in the UK 1979-1989*. Sandy/ Peterborough, Royal Society for the Protection of Birds/Nature Conservancy Council. 52 pp.

RSPB, BirdLife International, Wildfowl & Wetlands Trust, Game Conservancy Trust, British Trust for Ornithology, Hawk and Owl Trust, Wildlife Trusts & National Trust 1996 *Birds of Conservation Concern*. RSPB, Sandy. 6 pp.

Sandeman, PW 1957 The breeding success of golden eagles in the southern Grampians. *The Scottish Naturalist 69*: 148-152.

Schläpfer, A 1988 Populationsökologie des Feldlerche *Alauda arvensis* in der intensiv genutzten Agrarlandschaft. *Der Ornithologische Beobachter 85*: 309-371.

Scottish Ornithologists' Club on behalf of the Scottish Raptor Study Groups 1997 1996 Raptor round up. *Scottish Birds 19* (Supplement): 20 pp.

Scottish Ornithologists' Club on behalf of the Scottish Raptor Study Groups 1998 1997 Raptor round up. *Scottish Birds 19* (Supplement): 20 pp.

Scottish Homing Union 1998 *Attacks by peregrines & sparrowhawks on racing pigeons in Scotland*. Hamilton, Scottish Homing Union. 29 pp.

Scottish Natural Heritage 1994 *Red deer and the natural heritage*. SNH Policy Paper. Battleby, Scottish Natural Heritage. 70 pp.

Scottish Natural Heritage 1996 *A muirburn code*. Battleby, Scottish Natural Heritage. 16 pp.

Scottish Office 1998 *Counting the cost. The continuing persecution of birds of prey in Scotland*. Edinburgh, The Scottish Office. 18 pp.

Scottish Raptor Study Groups 1997 The illegal persecution of raptors in Scotland. *Scottish Birds 19*: 65-85.

Scottish Raptor Study Groups 1998 *The illegal persecution of raptors in Scotland*. Edinburgh, The Stationery Office. (Scottish Office Central Research Unit, Research Findings No. 17). 21 pp.

Sharrock, JTR 1976 *The atlas of breeding birds in Britain and Ireland*. Berkhampstead, Poyser. 477 pp.

Shawyer, C, Clarke, R & Dixon, N 1999 *A study into the raptor predation of domestic pigeons* Columba livia. Contract report from Hawk and Owl Trust to DETR and DoENI.

Shrubb, M 1990 Effects of agricultural change on nesting lapwings *Vanellus vanellus* in England and Wales. *Bird Study 37*: 115-127.

Shrubb, M 1994 *Welsh Bird Report No. 7* 1993. Glamorgan, The Welsh Ornithological Society.

Shrubb, M 1998 *Welsh Bird Report, Vol. 2(2)*. Glamorgan, The Welsh Ornithological Society.

Sim, IMW, Gibbons, DW, Bainbridge, I & Mattingley, W 1999 *Status of the hen harrier* Circus cyaneus *in the UK and the Isle of Man in 1998*. Draft report to Raptor Working Group.

Sim, IMW, Campbell, LH, Pain, DJ & Wilson, JD In press Correlates of the population increase of common buzzards *Buteo buteo* in the West Midlands between 1983 and 1996. *Bird Study*.

Smith, A, Redpath, S & Campbell, S 1999 *The influence of moorland management on grouse and their predators*. Unpublished Game Conservancy Trust/Institute of Terrestrial Ecology report to DETR.

Stone, BH Sears, J, Cranswick, PA, Gregory, RD, Gibbons, DW, Rehfisch, MM, Aebischer, NJ, & Reid, JB 1997 Population estimates of birds in Britain and in the United Kingdom. *British Birds 90*: 1-22.

Summers-Smith, JD 1996. *The tree sparrow*. Guisborough, JD Summers-Smith.

Sydes, C & Miller, GR 1988 Range management and nature conservation in the British uplands. *In: Ecological change in the uplands*, ed. by MB Usher & DBA Thompson, 323-337. Oxford, Blackwell.

Tapper, S 1992 *Game heritage. An ecological review from shooting and gamekeeping records*. Fordingbridge, The Game Conservancy. 140 pp.

Tapper, S ed. 1999 *A question of balance. Game animals and their role in the British countryside*. Fordingbridge, Game Conservancy Trust. 288 pp.

Tapper, SC, Potts, GR & Brockless, MH 1996 The effect of experimental reductions in predator presence on the breeding success and population density of grey partridges. *Journal of Applied Ecology 33*: 968-979.

Taylor, K, Hudson, R & Horne, G 1988 Buzzard breeding distribution and abundance in Britain and Northern Ireland in 1983. *Bird Study 35*: 109-118.

Thirgood, S & Redpath, S 1997 Red grouse and their predators. *Nature 390*: 547.

Thompson, DBA, Macdonald, AJ, Marsden, JH & Galbraith, CA 1995a Upland heather moorland in Great Britain: A review of international importance, vegetation change and some objectives for nature conservation. *Biological Conservation 71*: 163-178.

Thompson, DBA, Hester, AJ & Usher, MB eds. 1995b *Heaths and moorland: cultural landscapes*. Edinburgh, HMSO. 400 pp.

Thompson, DBA, Gillings, S Galbraith, CA, Redpath, SM & Drewitt, J 1997 The contribution of game management to biodiversity: a review of the importance of grouse moors for upland birds. I*n: Biodiversity in Scotland: status, trends and initiatives*, ed. by LV Fleming, AC Newton, JA Vickery and MB Usher, 198-212. Edinburgh, The Stationery Office.

Thomson, DL, Green, RE, Gregory, RAP & Baillie, SR 1998 The widespread declines in songbirds in rural Britain do not correlate with the spread of their avian predators. *Proceedings of the Royal Society, London B, 265* 2057-2062.

Tiainen, J, Hanski, LK, Pakkala, Y, Piiruoinen, J & Yrjölä, R 1989 Clutch-size, nestling growth and nestling mortality of the starling *Sturnus vulgaris* in south Finnish agro environments. Ornis Fennica 66: 41-48.

Tubbs, CR 1974 *The buzzard*. Newton Abbot & London, David & Charles. 199 pp.

Tucker, GM & Heath, M 1994. *Birds in Europe: their conservation status*. Cambridge, BirdLife International. 600 pp.

UK Biodiversity Group 1999 *UK Biodiversity Group. Tranche 2: Action Plans. Volume VI – terrestrial and freshwater species and habitats*. Peterborough, English Nature. 233 pp.

Underhill-Day, J 1998 Breeding marsh harriers in the United Kingdom, 1983-95. *British Birds 91*: 210-218.

Usher, MB & Thompson, DBA 1993 Variation in the upland heathlands of Great Britain: conservation importance. *Biological Conservation 66*: 69-81.

Ward, SD, Macdonald, AJ & Matthew, EM 1995 Scottish heaths and moorland: how should conservation be taken forward? *In: Heaths and moorland: cultural landscapes*, ed. by DBA Thompson, AJ Hester and MB Usher, 319-333. Edinburgh, HMSO.

Watson, A 1985 Social class, socially-induced loss, recruitment and breeding in red grouse. *Oecologia 67*: 493-498.

Watson, A, Payne, S & Rae, R 1989 Golden eagles *Aquila chrysaetos*; land use and food in northeast Scotland. *Ibis 131*: 336-348.

Watson, D & Rollie, C 1997 Breeding hen harriers in the UK 1997. *Scottish Bird News 48*: 3.

Watson, J 1997 *The golden eagle*. London, T & AD Poyser. 374 pp.

Watson, M 1998 *Hen harrier translocation as a conservation tool in the United Kingdom – a feasibility study*. Fordingbridge, Game Conservancy Trust. 48 pp.

Wilkinson, NI, Langston, RHW, Gregory, RD, Summers, RW, Gibbons, DW & Marquiss, M In prep Abundance and habitat selection of capercaillie *Tetrao urogallus* in Scotland in winter 1998-99.

Williams, IT & Parr, S 1995 Breeding merlins *Falco columbarius* in Wales 1993. *Welsh Birds 1*: 14-20.

Wilson, JD, Evans, J, Browne, SJ & King, JR 1997 Territory distribution and breeding success of skylarks *Alauda arvensis* on organic and intensive farmland in southern England. *Journal of Applied Ecology 34*: 1462 1478.

Yapp, WB 1982 Birds in captivity in the Middle Ages. *Archives of Natural History 10*: 479-500.

Annex 1

Annex 1: The Raptor Forum

Organisations represented at one or more of the fora of interested parties in 1995, 1996, 1997 or 1998 in London

Agriculture Department Advisory Service
British Association for Shooting and Conservation
British Field Sports Society
British Ornithologists' Union
British Trust for Ornithology
Confederation of Long Distance Racing Pigeon Unions of GB and NI
Country Landowners Association
Countryside Alliance
Countryside Council for Wales
Department of Agriculture for Northern Ireland
Department of the Environment, Transport and the Regions
English Nature
Farmers Union of Wales
Farming and Rural Conservation Agency
Farming and Wildlife Advisory Groups
Forest Enterprise
Forestry Authority
Game Conservancy Trust
Hawk and Owl Trust
Hawk Board
Institute of Terrestrial Ecology
Joint Nature Conservation Committee
Ministry of Agriculture, Fisheries and Food
Moorland Association
Moorland Gamekeepers Association
National Farmers Union
National Farmers Union for Scotland
National Gamekeepers Association
National Pigeon Association
National Trust
North of England Homing Union
North West Protection Group
Royal Racing Pigeon Association
Royal Society for the Protection of Birds
RSNC – The Wildlife Trust Partnership
Scottish Crofters Union
Scottish Homing Union
Scottish Landowners Federation
Scottish Natural Heritage
Scottish Office
Scottish Raptor Study Groups
Scottish Wildlife Trust
Wales Raptor Study Groups
Welsh Homing Pigeon Union
Welsh Office
Welsh Office Agriculture Department

Dates and places of meetings of the Raptor Forum

1 24 April 1995
Cavalry House, Duke of York's Headquarters, London

2 8 October 1996
Department of the Environment, Marsham Street, London

3 19 November 1997
Department of the Environment, Transport and the Regions, Marsham Street, London

4 10 December 1998
Department of the Environment, Transport and the Regions, Ashdown House, London

Annex 2: The UK Raptor Working Group

List of members

Chairs

Dr C.A. Galbraith, Joint Nature Conservation Committee [Co-chair]

R. Groombridge, Department of the Environment (Co-chair) {1995-1996}

C. Tucker, Department of the Environment, Transport and the Regions (Co-chair) {1996-present}

Current members

Dr I. Bainbridge/G.M. Williams, Royal Society for the Protection of Birds

Major E.C. Camilleri, The Confederation of Long Distance Racing Pigeon Unions of Great Britain and Northern Ireland (also representing the Royal Pigeon Racing Association)

J. Clorley, Department of the Environment, Transport and the Regions (Joint Secretariat) {1996-present}

J. Drysdale, Scottish Landowners Federation

A. Laws/A. Semple, British Association for Shooting and Conservation

Prof. J. Miles, Scottish Executive Rural Affairs Department, Environment Group

Prof. I. Newton, Institute of Terrestrial Ecology

Dr G.R. Potts/Dr S. Tapper/Dr S. Thirgood, Game Conservancy Trust

P. Stirling-Aird, Scottish Raptor Study Groups

D.A. Stroud, Joint Nature Conservation Committee (Joint Secretariat) {1996-present}

Past members

T. Emm, Department of the Environment (Joint Secretariat) {1995-1996}

Dr I.M. Evans, Joint Nature Conservation Committee (Joint Secretariat) {1995-1996}

Dr P. Robertson, Game Conservancy Trust {1996-1998}

Dates and places of Raptor Working Group meetings

1 29 September 1995
Department of the Environment, Marsham Street, London

2 28 November 1995
Scottish Office, St. Andrew's House, Edinburgh

3 31 January 1996
Department of the Environment, Marsham Street, London

4 2 April 1996
Scottish Office, St. Andrew's House, Edinburgh

5 16-17 July 1996
Joint Nature Conservation Committee, Monkstone House, Peterborough

6 9 September 1996
Department of the Environment, Marsham Street, London

7 19 November 1996
Department of the Environment, Marsham Street, London

8 15 May 1997
Scottish Office Agriculture, Environment and Fisheries Department, Pentland House, Edinburgh

9 16 July 1997
Scottish Office Agriculture, Environment and Fisheries Department, Pentland House, Edinburgh

10 17-18 September 1997
Joint Nature Conservation Committee, Monkstone House, Peterborough

11 16 October 1997
Department of the Environment, Transport and the Regions, Tollgate House, Bristol

12 22 January 1998
Scottish Office Agriculture, Environment and Fisheries Department, Pentland House, Edinburgh

13 15 April 1998
Scottish Office Agriculture, Environment and Fisheries Department, Pentland House, Edinburgh

14 20 May 1998
Department of the Environment, Transport and the Regions, Tollgate House, Bristol

15 20-21 July 1998
Atholl Palace, Pitlochry

16 15 September 1998
Scottish Natural Heritage, Anderson Place, Edinburgh

17 3 November 1998
Department of the Environment, Transport and the Regions, Eland House, London

18 27 January 1999
Joint Nature Conservation Committee, Monkstone House, Peterborough

19 18 March 1999
Scottish Office Agriculture, Environment and Fisheries Department, Pentland House, Edinburgh

20 29 April 1999
Department of the Environment, Transport and the Regions, Great Minster House, London

21 30 June 1999
Scottish Natural Heritage, Anderson Place, Edinburgh

22 9 August 1999
Department of the Environment, Transport and the Regions, Tollgate House, Bristol

23 15 September 1999
Scottish Executive, Victoria Quay, Edinburgh

24 25-26 October 1999
Joint Nature Conservation Committee, Monkstone House, Peterborough

25 29-30 November 1999
Scottish Natural Heritage, Battleby

Acknowledgements

The Raptor Working Group would like to express its appreciation to Sarah Jones (DETR), and to Joanne Day and Ricky Mexson (JNCC) as well as Jane Lawson and Marion Whitelaw (SNH) for their administrative support in arranging numerous meetings, as well as in the production (to tight deadlines) and circulation of the drafts of the Group's report. We are grateful also to Trudi Harris (JNCC) and Fiona MacTaggart (SNH) who oversaw the production and printing of the final report.

Annex 3: Submissions to Working Group (written and oral)

Written submissions (material supplied to the Group by members or otherwise received)

Less substantive items such as correspondence and internal working papers (*e.g.* research proposals) are not listed. Where publications clearly cover several topics they are listed twice.

National status and conservation of birds of prey

Bibby, CJ & Etheridge, B 1993 Status of the hen harrier *Circus cyaneus* in Scotland in 1988-89. *Bird Study 40:* 1-11.

British Trust for Ornithology, Hawk and Owl Trust, National Trust, National Trust for Scotland, Royal Society for the Protection of Birds, Scottish Raptor Study Groups, Wales Raptor Study Group, The Wildlife Trusts, Scottish Ornithologists' Club, Wildfowl & Wetlands Trust, & World Wide Fund for Nature (WWF-UK) 1997 *Birds of prey in the UK: back from the brink*. 12 pp (including inserts on: birds of prey and domestic pigeons; birds of prey and songbirds; and birds of prey and red grouse).

British Trust for Ornithology, Hawk and Owl Trust, National Trust, Royal Society for the Protection of Birds, Scottish Raptor Study Groups, Wales Raptor Study Group & the Wildlife Trusts 1995 *Birds of prey in the UK: a review and implications for future policies*. Report to DETR/JNCC Raptor Working Group. 72 pp.

Crick, HQP & Ratcliffe, DA 1995 The peregrine *Falco peregrinus* breeding population of the United Kingdom in 1991. *Bird Study 42*: 1-19.

Etheridge, B, Summers, RW & Green, RE 1997 The effects of illegal killing and destruction of nests by humans on the population dynamics of the hen harrier *Circus cyaneus* in Scotland. *Journal of Applied Ecology 34*: 1081 1105.

Hinsley, SA & Redpath, S 1996 *Impacts of raptor predation on red grouse, homing pigeons and songbirds in Britain*. Unpublished report to JNCC/SOAEFD. 74 pp.

Holling, M & McGarry, O 1994 A review of the changing status of buzzard in the Borders. *Borders Bird Report 14*: 76-82.

Holmes, J, Walker, D, Davies, P & Carter, I 2000 *The illegal persecution of raptors in England*. Peterborough, English Nature. (English Nature Research Report).

Morton, K, O'Toole, L & Orr-Ewing, D 1998 *Red kites poisoned in Scotland* 1997 & 1998. Confidential report commissioned from RSPB by DETR/JNCC Raptor Working Group. 24 pp.

Newton, I 1994 Current population levels of diurnal raptors in Britain. *The Raptor 21*: 17-21.

Newton, I, Wyllie, I & Dale, L 1999 Trends in the numbers and mortality patterns of sparrowhawks and kestrels in Britain as revealed by carcass analyses. *Journal of Zoology 24*: 139-147.

Potts, GR 1998 Global dispersion of nesting hen harriers *Circus cyaneus*; implications for grouse moors in the UK *Ibis 140*: 76-88.

Rebecca, G & Bainbridge, IP 1998 The breeding status of the merlin *Falco columbarius* in Britain in 1993-94. *Bird Study 45*: 172-187.

Royal Society for the Protection of Birds 1995a *Offences against wild bird legislation 1994*. Sandy, Royal Society for the Protection of Birds.

Royal Society for the Protection of Birds 1995b *Bird of prey persecution in Scotland in 1994*. Edinburgh, Royal Society for the Protection of Birds. 17 pp.

Royal Society for the Protection of Birds 1996a *Persecution: a review of bird of prey persecution in the UK in 1995*. Sandy, Royal Society for the Protection of Birds.

Royal Society for the Protection of Birds 1996b *Persecution: A review of bird of prey persecution in the Scotland in 1995*. Edinburgh, Royal Society for the Protection of Birds.

Royal Society for the Protection of Birds 1997a *Persecution: a review of bird of prey persecution in the UK in 1996*. Sandy, Royal Society for the Protection of Birds.

Royal Society for the Protection of Birds 1997b *Persecution: a review of bird of prey persecution in Scotland in 1996*. Edinburgh, Royal Society for the Protection of Birds.

Royal Society for the Protection of Birds 1998a *Persecution: a review of bird of prey persecution in Scotland in 1997*. Edinburgh, Royal Society for the Protection of Birds.

Royal Society for the Protection of Birds 1999a *Persecution: a review of bird of prey persecution in Scotland in 1998*. Edinburgh, Royal Society for the Protection of Birds. 22 pp.

Royal Society for the Protection of Birds 1999b *Birdcrime '98. Offences against wild bird legislation 1998*. Sandy, Royal Society for the Protection of Birds. 48 pp.

Royal Society for the Protection of Birds/Scottish Natural Heritage 1998 *Red Kite Scottish Newsletter No. 9*. 8 pp.

Scottish Office 1998b *Counting the cost. The continuing persecution of birds of prey in Scotland*. Edinburgh, The Scottish Office. 18 pp.

Scottish Ornithologists' Club 1992 Raptor round up 1991. *Scottish Bird News 26*: 1-3.

Scottish Ornithologists' Club 1993 Raptor round up 1992. *Scottish Bird News 30*: 69.

Scottish Ornithologists' Club 1994 Raptor round up 1993. *Scottish Bird News 34*: 1-5.

Scottish Ornithologists' Club 1995 Raptor round up 1994. *Scottish Bird News 38*: 8-12.

Scottish Ornithologists' Club on behalf of the Scottish Raptor Study Groups 1996 1995 Raptor round up. *Scottish Birds 18* (Supplement): 20 pp.

Scottish Ornithologists' Club on behalf of the Scottish Raptor Study Groups 1997 1996 Raptor round up. *Scottish Birds 19* (Supplement): 20 pp.

Scottish Ornithologists' Club on behalf of the Scottish Raptor Study Groups 1998 1997 Raptor round up. *Scottish Birds 19* (Supplement): 20 pp.

Scottish Raptor Study Groups 1997 The illegal persecution of raptors in Scotland. *Scottish Birds 19*: 65-85.

Scottish Raptor Study Groups 1998 *The illegal persecution of raptors in Scotland*. Edinburgh, The Stationery Office. (Scottish Office Central Research Unit, Research Findings No. 17.) 21 pp.

Sim, IMW, Campbell, LH, Pain, DJ & Wilson, JD in press Correlates of the population increase of common buzzards *Buteo buteo* in the West Midlands between 1983 and 1996. *Bird Study*.

Stone, BH, Sears, J, Cranswick, PA, Gregory, RD, Gibbons, DW, Rehfisch, MM, Aebischer, NJ & Reid, JB 1997 Population estimates of birds in Britain and in the United Kingdom. *British Birds 90*: 1-22.

Pigeons and raptors

British Trust for Ornithology, Hawk and Owl Trust, National Trust, National Trust for Scotland, Royal Society for the Protection of Birds, Scottish Raptor Study Groups, Wales Raptor Study Group, The Wildlife Trusts, Scottish Ornithologists' Club, Wildfowl & Wetlands Trust & World Wide Fund for Nature (WWF-UK) 1997 *Birds of prey in the UK: back from the brink*. 12 pp (including inserts on: birds of prey and domestic pigeons; birds of prey and songbirds; and birds of prey and red grouse).

Gorssen, J & van der Hel, W 1996 *Climatic requirements of racing pigeons during transport: a brief research overview*. Wageningen, Department of Animal Husbandry, Agricultural University.

Hinsley, SA & Redpath, S 1996 *Impacts of raptor predation on red grouse, homing pigeons and songbirds in Britain*. Unpublished report to JNCC/SOAEFD. 74 pp.

Kenward, R 1986 Problems of goshawk predation on pigeons and other game. *In: Proceedings of the XVIII International Ornithological Congress*, pp. 666-678.

Lewis, N 1991 *Report on peregrine prey species* 1984-1990. Unpublished report.

Mentinck, P 1996 Pigeons and raptors. *BTO News 205*: 6.

Musgrove, A 1996 *Peregrines and pigeons: investigations into a raptor-human conflict*. PhD thesis, University of Bristol.

Musgrove, A 1998 Peregrines and pigeons (again!). *BTO News 214*: 11.

Royal Pigeon Racing Association 1992 *Pigeon racing: a family sport*. Cheltenham, RPRA . 12 pp.

Royal Pigeon Racing Association 1996 *Pigeon racing*. Cheltenham, RPRA. Results of questionnaire survey. 6 pp.

Scottish Homing Union 1998 *Attacks by peregrines & sparrowhawks on racing pigeons in Scotland*. Hamilton, SHU. 29 pp.

Shawyer, C, Clarke, R & Dixon, N 1998 *A study into the raptor predation of domestic pigeons* Columba livia. Unpublished contract report from Hawk and Owl Trust to DETR and DoENI. 115 pp.

Status and conservation of moorland birds of prey and red grouse

Bibby, CJ & Etheridge, B 1993 Status of the hen harrier *Circus cyaneus* in Scotland in 1988-89. *Bird Study 40*: 1-11.

British Association for Shooting and Conservation/English Nature 1999 *The gamekeeper. Professional countryside manager*. Wrexham/Peterborough, BASC/EN. 16 pp.

British Trust for Ornithology, Hawk and Owl Trust, National Trust, National Trust for Scotland, Royal Society for the Protection of Birds, Scottish Raptor Study Groups, Wales Raptor Study Group, The Wildlife Trusts, Scottish Ornithologists' Club, Wildfowl & Wetlands Trust & World Wide Fund for Nature (WWF-UK) 1997 *Birds of prey in the UK: back from the brink*. 12 pp (including inserts on: birds of prey and domestic pigeons; birds of prey and songbirds; and birds of prey and red grouse).

British Trust for Ornithology, Hawk and Owl Trust, National Trust, Royal Society for the Protection of Birds, Scottish Raptor Study Groups, Wales Raptor Study Group & the Wildlife Trusts 1995 *Birds of prey in the UK: a review and Implications for future policies*. Report to DETR/JNCC Raptor Working Group. 72 pp.

Crick, HQP & Ratcliffe, DA 1995 The peregrine *Falco peregrinus* breeding population of the United Kingdom in 1991. Bird Study 42: 1-19.

Cumbria Raptor Study Group 1998 *Bird of prey persecution in Cumbria*. Unpublished report. 4 pp.

Dick, TD & Stronach, A 1998 *The use, abuse and misuse of crow cage traps in Scotland*. Report on behalf of Scottish Raptor Study Groups and RSPB to SOAEFD. 14 pp.

Dick, TD & Stronach, A 1999 The use, abuse and misuse of crow cage traps in Scotland: a report on behalf of the Scottish Raptor Study Groups and RSPB. *Scottish Birds 20*: 6-13.

Durham Upland Bird Study Group 1998 *Bird persecution in the Durham Pennines*. Report to DETR/JNCC Raptor Working Group. 3 pp.

Etheridge, B, Summers, RW & Green, RE 1997 The effects of illegal killing and destruction of nests by humans on the population dynamics of the hen harrier *Circus cyaneus* in Scotland. *Journal of Applied Ecology 34*: 1081 1105.

Environmental Panel of the Advisory Committee on Pesticides 1997 *Pesticide poisoning of animals 1996. Investigations of suspected incidents in the United Kingdom*. London, MAFF. 50 pp.

Game Conservancy Trust 1998 *Hen harriers on grouse moors. A response by the Game Conservancy Trust to 'A Future for grouse moors: a call to action' published by a partnership of conservation NGOs*. Unpublished submission to DETR/JNCC Raptor Working Group. 10 pp.

Green, RE & Etheridge, B 1999 Breeding success of the hen harrier in relation to the distribution of grouse moors and the red fox *Vulpes vulpes*. *Journal of Applied Ecology 36*: 472-483.

Hardey, J 1998 *Peregrine falcon NE Scotland 1998. Breeding success*. Unpublished report by North East of Scotland Raptor Study Group. 2 pp.

Hawk and Owl Trust, National Trust, Royal Society for the Protection of Birds, Scottish Ornithologists' Club, Scottish Raptor Study Groups, North of England Raptor and Upland Bird Study Groups, The Wildlife Trusts (UK) & World Wide Fund for Nature 1998a *A future for grouse moors – a call to action*.

Hawk and Owl Trust, National Trust, Royal Society for the Protection of Birds, Scottish Raptor Study Groups, Wales Study Group, North of England Raptor and Upland Bird Study Groups, The Wildlife Trusts (UK), Scottish Ornithologists' Club & World Wide Fund for Nature 1998b *Quota and translocation schemes for hen harriers the view of the partnership of conservation NGOs*.

Hinsley, SA & Redpath, S 1996 *Impacts of raptor predation on red grouse, homing pigeons and songbirds in Britain*. Unpublished report to JNCC/SOAEFD. 74 pp.

Holling, M & McGarry, O 1994 A review of the changing status of buzzard in the Borders. *Borders Bird Report 14*: 76-82.

Holmes, J, Walker, D, Davies, P & Carter, I 2000 *The illegal persecution of raptors in England*. Peterborough, English Nature. (English Nature Research Report.)

Hudson, PJ, Newborn, D & Robertson, PA 1997 Geographical and seasonal patterns of mortality in red grouse populations. *Wildlife Biology 3*: 79-87.

May, RM 1999 Crash tests for real. *Nature 398*: 371-372.

Newton, I 1994 Current population levels of diurnal raptors in Britain. *The Raptor 21*: 17-21.

MAFF Health and Safety Commission 1998 *Code of practice for the safe use of pesticides on farms and holdings*. London, MAFF. 111 pp.

Moorland Working Group 1999 *Substitute feeding of hen harriers on grouse moors*. Battleby, Scottish Natural Heritage. 20 pp.

Morton, K, O'Toole, L & Orr-Ewing, D 1998 *Red kites poisoned in Scotland 1997 & 1998. An examination of the circumstances and significance of the illegal poisoning of eight red kites in Scotland in 1997 and 1998*. Confidential RSPB report to DETR/JNCC Raptor Working Group. 24 pp.

Northumbria Ringing Group 1998 *Raptor persecution data, Northumberland*. Unpublished report. 2 pp.

North West Raptor Protection Group 1998 *An account of the illegal persecution of raptors in the north west of England*. Unpublished report. 6 pp.

Potts, GR 1998 Global dispersion of nesting hen harriers *Circus cyaneus*; implications for grouse moors in the UK *Ibis 140*: 76-88.

Rebecca, G & Bainbridge, IP 1998 The breeding status of the Merlin *Falco columbarius* in Britain in 1993-94. *Bird Study 45*: 172-187.

Redpath, SM 1998 *Management trial to reduce hen harrier predation on red grouse at Langholm 1998: the effects of providing hen harriers with supplementary food*. ITE contract report to SNH (Contract BAT/98/99/015). 35 pp.

Redpath, SM & Thirgood, SJ 1997 *Birds of prey and red grouse*. London, The Stationery Office. 148 pp.

Smith, A, Redpath, S & Campbell, S 1999 *The influence of moorland management on grouse and their predators*. Unpublished Game Conservancy Trust/Institute of Terrestrial Ecology report to DETR. 74 pp.

Stott, M 1998 Hen harrier breeding success on English grouse moors. *British Birds 91*: 107-109.

Watson, M 1998 *Hen harrier translocation as a conservation tool in the United Kingdom – a feasibility study*. Fordingbridge, Game Conservancy Trust. 48 pp.

Moorland habitats and upland land use issues

Barton, AF & Robertson, PA 1997 *Land cover change in the Scottish uplands, 1945-1990, in relation to grouse management*. Unpublished Game Conservancy Trust report.

Drewitt, AL & Manley, VJ 1997 *The vegetation of the mountains and moorland of England. National assessment of significance*. Peterborough, English Nature. 33 pp. (English Nature Research Reports No. 218.)

Egdell, JM 1995 *The economics of upland grouse shooting: implications for wildlife*. Sandy, Royal Society for the Protection of Birds. Internal RSPB report. 66 pp.

English Nature 1996 *Land management for upland birds*. Peterborough, English Nature. 8 pp.

English Nature [undated] *Wildlife Enhancement Scheme: North Pennine Moorland Sites of Special Scientific Interest*. Peterborough, English Nature. 4 pp. (English Nature North and East Yorkshire Team report.)

Fuller, RJ & Gough, SJ 1999 Changes in sheep numbers in Britain: implications for bird populations. *Biological Conservation 91*: 73-89.

Gordon, G 1996 Balance of wildlife. *Landowning in Scotland 240*: 12-13.

Gordon-Cumming, W 1994 Scotland's uplands – the future. *Scottish Forestry 48*: 110.

Hankey, MS 1995 *Supporting the countryside – future opportunities*. Edinburgh, Scottish Landowners Federation. 40 pp.

Harding, NJ, Green, RE & Summers, RW 1994 *The effects of future changes in land use on upland birds in Britain*. Edinburgh, Royal Society for the Protection of Birds. 148 pp.

Hawk and Owl Trust, National Trust, Royal Society for the Protection of Birds, Scottish Ornithologists' Club, Scottish Raptor Study Groups, North of England Raptor and Upland Bird Study Groups, The Wildlife Trusts (UK) & World Wide Fund for Nature 1998. *A future for grouse moors – a call to action*.

Hooper S 1996 *The Wildlife Enhancement Scheme in the uplands*. Peterborough, English Nature. 20 pp. (English Nature Research Report, No. 199.)

Hudson, PJ 1995 Ecological trends and grouse management in upland Britain. *In: Heaths and moorland: cultural landscapes*, ed. by DBA Thompson, AJ Hester and MB Usher, 283-293. Edinburgh, HMSO.

Jackson, T 1999 All points north. *Shooting Times and Country Magazine*, 12 August: 22-24.

Jerram, R & Drewitt, A 1998 *Assessing vegetation condition in the English uplands*. Peterborough, English Nature. 36 pp. (English Nature Research Report, No. 264.)

Lovegrove, R, Shrubb, M & Williams, I 1995 *Silent fields. Gwlad Tawel. The current status of farmland birds in Wales*. Sandy, Royal Society for the Protection of Birds. 33 pp.

MAFF 1999 *The Countryside Stewardship Scheme. Information and how to apply*. London, MAFF. 80 pp.

Magnusson, M 1995 Foreword. *In: Heaths and moorland: cultural landscapes* ed. by DBA Thompson, AJ Hester and MB Usher, xii-xvi. Edinburgh, HMSO.

McFerran, DM, Hegarty, CA, Cameron, A, Mulholland, FP & McAdam, JH 1995 Monitoring of heather moorland within Environmentally Sensitive Areas in Northern Ireland. *In: Heaths and moorland: cultural landscapes* ed. by DBA Thompson, AJ Hester and MB Usher, 340-343. Edinburgh, HMSO.

McGilvray, J & Perman, R 1991 *Grouse shooting in Scotland: an analysis of its importance to the economy and environment*. Report of the Game Conservancy Trust's Grouse Research Project. 89 pp.

McGilvray, J 1995 *An economic study of grouse moors*. Glasgow, University of Strathclyde. 36 pp.

Ministry of Agriculture, Fisheries and Food 1996 *Environmentally Sensitive Areas and other schemes under the Agri-Environment Regulation*. Memorandum of Evidence to House of Commons Select Committee on Agriculture.

Moorland Working Group 1998 *Good practice for grouse moor management*. Battleby, Scottish Natural Heritage. 24 pp.

Phillips, J 1991 Heather burning and management 1911 1991. *Heather Trust Annual Report 1991*: 41-44.

Phillips, J 1998. Life after Langholm. *Heather Trust Annual Report 1998*: 21.

Phillips, J & Watson, A 1995 Key requirements for management of heather moorland: now and for the future. *In: Heaths and moorland: cultural landscapes* ed. by DBA Thompson, AJ Hester and MB Usher, 344-361. Edinburgh, HMSO.

Ramsay, P 1996 Don't blame the raptors. *Landowning in Scotland 240*: 15.

Scottish Office Agriculture, Environment and Fisheries Department 1996 *Scottish Agriculture: a guide to grants and services*. Edinburgh, SOAEFD.

Scottish Office Agriculture, Environment and Fisheries Department 1998 *Countryside Premium Scheme*. Edinburgh, SOAEFD. 40 pp.

Smith, A, Redpath, S & Campbell, S 1999 *The influence of moorland management on grouse and their predators*. Unpublished Game Conservancy Trust/Institute of Terrestrial Ecology report to DETR.

Straker-Smith, P & Phillips, J 1994 The logistics and arithmetic of heather burning. *Heather Trust Annual Report 1994*: 25-27.

The Wildlife Trusts 1996 *Crisis in the hills: overgrazing in the uplands*. Lincoln, RSNC.

Thompson, DBA & Miles, J 1995 Heaths and moorland: some conclusions and questions about environmental change. *In: Heaths and moorland: cultural landscapes* ed. by DBA Thompson, AJ Hester and MB Usher, 362-385. Edinburgh, HMSO.

Thompson, DBA, Gillings, S Galbraith, CA, Redpath, SM & Drewitt, J 1997 The contribution of game management to biodiversity: a review of the importance of grouse moors for upland birds. *In: Biodiversity in Scotland: status, trends and initiatives* ed. by LV Fleming, AC Newton, JA Vickery and MB Usher, 198-212. Edinburgh, The Stationery Office.

Ward, SD, MacDonald, AJ & Matthew, EM 1995 Scottish heaths and moorland: how should conservation be taken forward? *In: Heaths and moorland: cultural landscapes* ed. by DBA Thompson, AJ Hester and MB Usher, 319-333. Edinburgh, HMSO.

Watson, A 1998 A further response to Langholm. Scottish *Bird News 51*: 2.

Lowland bird issues

British Association for Shooting and Conservation/English Nature 1999 *The gamekeeper. Professional countryside manager*. Wrexham/Peterborough, BASC/EN. 16 pp.

British Association for Shooting and Conservation 1996 *Raptors and game shooting survey*. Questionnaire Wrexham, BASC. 8 pp.

British Trust for Ornithology, Hawk and Owl Trust, National Trust, National Trust for Scotland, Royal Society for the Protection of Birds, Scottish Raptor Study Groups, Wales Raptor Study Group, The Wildlife Trusts, Scottish Ornithologists' Club, Wildfowl & Wetlands Trust & World Wide Fund for Nature (WWF-UK) 1997 *Birds of prey in the UK: back from the brink*. 12 pp (including inserts on: birds of prey and domestic pigeons; birds of prey and songbirds; and birds of prey and red grouse).

Campbell, LH, Avery, MI, Donald, P, Evans, AD, Green, RE & Wilson, JD 1997 *A review of the indirect effects of pesticides on birds*. Peterborough, Joint Nature Conservation Committee. 148 pp. (JNCC Report, No. 227.)

Harradine, J, Reynolds, N & Laws, T 1997 *Raptors and gamebirds – a survey of game managers affected by raptors*. Wrexham, BASC. 39 pp.

Hinsley, SA & Redpath, S 1996 *Impacts of raptor predation on red grouse, homing pigeons and songbirds in Britain*. Unpublished report to JNCC/SOAEFD. 74 pp.

Holmes, J, Walker, D, Davies, P & Carter, I 1999 *The illegal persecution of raptors in England*. Peterborough, English Nature. (English Nature Research Report).

Kenward, RE [undated] *Raptor predation problems and solutions*. Unpublished ITE report.

Kenward, RE & Marcström, V 1982 Goshawk predation on game and poultry: some problems and solutions. *Understanding the goshawk*: 152-162.

Kenward, RE, Marcström, V & Karlbom, M 1991 The goshawk (*Accipiter gentilis*) as predator and renewable resource. Gibier Faune Sauvage 8: 367-378.

Lloyd, DEB 1976a *Avian predation of reared pheasants*. Report for the British Field Sports Society, Game Conservancy, Royal Society for the Protection of Birds and the Wildfowlers Association of Great Britain and Ireland.

Lloyd, DEB 1976b *The predation of pheasants in release pens from birds of prey*. British Field Sports Society, The Game Conservancy, Royal Society for the Protection of Birds and the Wildfowlers Association of Great Britain and Ireland. 12 pp.

Lovegrove, R, Shrubb, M & Williams, I 1995 *Silent fields. Gwlad Tawel. The current status of farmland birds in Wales*. Sandy, Royal Society for the Protection of Birds. 33 pp.

Legislation

Royal Society for the Protection of Birds 1996 *Wild birds and the law*. Sandy, Royal Society for the Protection of Birds. 31 pp.

Scottish Landowners Federation 1996 *Birds of prey, predation on grouse and the power to grant licences*. Report by SLF Legal Adviser.

Stroud, DA, Gibson, S, Holmes, JS & Harry, CM 1999 The legislative basis for vertebrate pest management in Europe (with examples from the UK). *In: Advances in vertebrate pest management* ed. by DP Cowan and CJ Feare, 85-108. Fürth, Filander Verlag.

Oral submissions

The following individuals or organisations were invited by the Group to discuss particular aspects of our work.

15 April 1998
Speaker/organisation: Scottish Homing Union (L. Brooks and colleagues)
Topic: Scottish Homing Union survey of raptor impacts on Scottish racing pigeons

20 May 1998
Speaker/organisation: J. Packer, ADAS Bristol
Topic: Campaign against the illegal poisoning of wildlife

Speaker/organisation: D. Thompson, British Trust for Ornithology
Topic: The impact of sparrowhawks on songbird populations

20 July 1998
Speaker/organisation: J. Phillips, Heather Trust
Topic: Moorland management techniques

3 November 1998
Speaker/organisation: D.B.A. Thompson, JNCC Upland Lead Agency Network
Topic: Biodiversity Action Plan for Upland Heaths and Moorlands

18 March 1999
Speaker/organisation: W. Williams, English Nature
Topic: English Nature's upland policies

Speaker/organisation: P. Welsh, English Nature
Topic: English Nature's Wildlife Enhancement Scheme in the North Pennines

Speaker/organisation: M. Rebane, English Nature
Topic: Agenda 2000

Speaker/organisation: I. Condliffe, Farming and Rural Conservation Agency
Topic: Agri-environment schemes for the uplands

Speaker/organisation: I. Sim, RSPB
Topic: Results of 1998 national hen harrier survey

29 April 1999
Speaker/organisation: C. Shawyer, R. Clarke & N. Dixon, Hawk and Owl Trust
Topic: Results of DETR commissioned research into raptor predation of domestic pigeons

30 June 1999
Speaker/organisation: S. Redpath, Institute of Terrestrial Ecology , & A. Smith, Game Conservancy Trust
Topic: Results of DETR commissioned research into effects of moorland management on grouse and their predators

Annex 4: Summary of status changes of birds of prey in Britain

The population history of each raptor species breeding in the UK over the last century and earlier is summarised below based on information provided by BTO *et al*. (1995). Species are listed in approximate decreasing order of the extent to which illegal poisoning, killing and deliberate destruction of adults, chicks or eggs, has influenced their population, starting with those that were made extinct in the UK, and then followed by those which are thought to be seriously limited by illegal killing at present.

The 'pre-1900 occurrence' provides an indication of what the population level of species could currently be. Seeking the return of raptor populations to former levels may be unrealistic as there have been both losses and increases in suitable habitat.

The term 'probable restricting factors' is used below to indicate those factors which evidence suggests are most important in preventing the species from reaching carrying capacity throughout the UK (including characteristics of the species' population biology, mentioned in parentheses as they cannot be addressed by human action – except, perhaps, re-establishment programmes) or in reducing the carrying capacity for raptor species of the UK. In other words these are key factors to be addressed in ensuring favourable conservation status for these species.

Species previously nationally extinct

White-tailed eagle

Pre-1900 occurrence: probably more than 200 pairs, spread around coastal areas and some inland sites, especially in Scotland (Newton 1979).

UK low point: extinction in 1916 due to illegal killing.

Recovery: a re-introduction programme by the Nature Conservancy Council (now Scottish Natural Heritage – SNH) and RSPB on Rum released 82 birds between 1975 and 1985 (Love 1988); the first wild chick was raised in 1985; in response to the very slow population growth (Green *et al*. 1996) a second re-introduction was begun in 1993 to supplement the first. In 1997, 13-15 nesting attempts occurred.

Probable restricting factors: illegal killing (slow intrinsic growth rate of small population).

Goshawk

Pre-1900 occurrence: widespread across the UK in woodland; one estimate suggested 1,000 pairs in England in the 11th century (Yapp 1982).

UK low point: extinction in late 19th century due to illegal killing and habitat loss.

Recovery: goshawks were re-established in Britain by falconers on an unregulated, unofficial basis, from the 1950s onward, with *c*. 250 birds being released or escaping in the 1970s alone (Kenward *et al*. 1981; Petty 1996). The population is now 400-450 pairs (Table 1; Petty 1996).

Probable restricting factors: illegal killing, especially in the lowlands.

Osprey

Pre-1900 occurrence: before records were kept probably bred commonly across the UK around coasts and inland waters; still some English breeding records in the 19th century; persisted in Scotland into the 20th century.

UK low point: extinct in 1916 due to illegal killing.

Recovery: a single pair recolonised Scotland (Strathspey) in 1954, presumably from Sweden; with the help of intensive protection and further immigration the population increased to 111 pairs by 1997, and has expanded from Strathspey over much of the Highlands.

Probable restricting factors: egg robbery (slow intrinsic rate of population growth and recovery).

Marsh harrier

Pre-1900 occurrence: widespread but scarce breeder in the UK in the 19th century, having been common in East Anglia and Ireland up to 1800 (Brown 1976).

UK low point: extinction in 1900 due to illegal killing and drainage of reedbed habitat.

Recovery: bred sporadically from 1911, and regularly from 1927, largely in East Anglia. The population declined again to a single nesting pair in 1971, perhaps due to organochlorine pesticides, but is now recovering (Underhill-Day 1998), there being 128-150 pairs in 1997, although well below historic levels, nesting mainly on areas where nests are actively protected, with a habitat switch onto arable fields.

Probable restricting factors: illegal killing, disturbance.

Species previously regionally extinct

Red kite

Pre-1900 occurrence: widespread throughout the UK before the 19th century.

UK low point: only two of 11 pairs successful in central Wales in 1931-1935 due to illegal killing (Davis 1993; Lovegrove *et al*. 1994).

Recovery: saved from UK extinction by intensive protection in Wales; since the 1960s, annual population growth of 5-8%, perhaps due to improved adult survival as poisoning has declined; in 1994 the population exceeded 100 pairs, but it is only expanding its range very slowly. To help re-establish the species in suitable habitat throughout Britain, a re-introduction programme began in southern England and northern Scotland in 1989; by 1998 the population of re-established birds was approximately 100 pairs and is increasing more rapidly than the Welsh population; a second phase of releases began in 1995 in the English Midlands and in 1996 in central Scotland (Evans *et al*. 1997, 1999).

Probable restricting factors: illegal killing, poisoning, shooting, egg collecting (Bibby *et al*. 1990) (slow intrinsic rate of population growth and range recovery of Welsh population).

Hen harrier

Pre-1900 occurrence: widespread throughout UK over many more habitats than at present.

UK low point: effectively restricted to Orkney and the Western Isles (although possibly a few also in Perthshire and south-west Scotland also (Watson 1977)) by the turn of the century largely due to illegal killing.

Recovery: began to recolonise mainland Scotland in the 1930s due to the availability of new forestry plantations (which provided nesting sites safe from illegal killing) and to reduced illegal killing (as the number of keepers employed on grouse moors fell). The species reached approximately its current distribution by the mid 1970s and in 1988-1989 the first full survey (Bibby & Etheridge 1993) calculated a UK and Isle of Man population of 578 (479 pairs in Scotland, with a further 99 in England, Wales, Northern Ireland and the Isle of Man). A second national survey in 1998 (Sim *et al*. 1999) found similar overall UK/Isle of Man numbers (570 territorial pairs) but with some regional changes. Numbers in Orkney have significantly declined (from 71 to 34 – see Meek *et al*. 1998), whilst in Northern Ireland there has been an increase from ten to 38. The total in Scotland outside Orkney has declined slightly from 408 in 1988, to 402 in 1998.

Probable restricting factors: illegal killing on grouse moors (Etheridge *et al*. 1997; Green & Etheridge 1999), maturation of conifer plantations; also loss and ecological deterioration of moorland breeding habitat and threats to winter roosts of habitat destruction, disturbance.

Species previously regionally extinct (continued)

Golden eagle

Pre-1900 occurrence: bred in hilly districts throughout the UK with perhaps 500 pairs in Scotland and at least 50 in England and Wales in the Middle Ages (Brown 1976); exterminated from Wales by the mid 18th and England by the mid 19th century.

UK low point: *c.* 150 pairs, restricted to Scotland, in *c.* 1900-1914 due to illegal killing (Love 1989).

Recovery: 420 pairs by the first comprehensive survey in 1982 (Dennis *et al.* 1984). The repeat survey in 1992 (Green 1996) found about the same population size, with some shifts in distribution.

Probable restricting factors: illegal killing, blanket afforestation, habitat deterioration through overgrazing (slow intrinsic rate of population growth and range recovery) (Watson 1997).

Buzzard

Pre-1900 occurrence: bred in all UK countries in 1800.

UK low point: eliminated from all but a few western districts by 1860 (Newton 1979).

Recovery: began around 1915 through to the 1950s when buzzard numbers declined following the introduction of myxomatosis in 1955, and the subsequent diminution in rabbit populations, a major food source for buzzards. Since the 1960s the population has continued to grow, albeit rather slowly. The BTO Nest Records Scheme shows that breeding performance has significantly improved (1962-1994) (Crick *et al.* 1998). In recent years the species has been spreading (Table 2.4): for example, in the last ten years it has re-colonised much of eastern England and Scotland due mainly to an apparent decline in poisoning (*e.g.* Holling & McGarry 1994) and current high numbers of rabbits (Sim *et al.* in press).

Probable restricting factors: illegal killing – poisoning and shooting (slow intrinsic rate of population growth and range recovery) (Elliot & Avery 1991; Gibbons *et al.* 1995).

Peregrine

Pre-1900 occurrence: 1,350 pairs in Britain and Ireland before 1800; 20% decline to 1,100 pairs by 1930 due to illegal killing and human-induced depletion of food supply; during the Second World War, more than 600 peregrines were officially destroyed, leading to the virtual elimination of the species from south-west England; numbers were close to being restored by 1955, except for a few sites in south-east England (Ratcliffe 1993). In the late 1950s and early 1960s an alarming decline in peregrine populations led to the discovery of the indirect effects of organochlorine pesticides on birds (Moore 1987).

British low point: *c.* 360 pairs, with under 150 pairs producing young in 1963 due to organochlorine pesticides (Ratcliffe 1972).

Recovery: substantial, following the withdrawal of organochlorines, and enhanced protection efforts, to over 700 pairs in the UK by 1981 and around 1,285 pairs in 1991 (1,600 pairs in Britain and Ireland). The national population is now at highest known levels, especially southern Scotland, north England and Wales. However, the species remains below pre-1940 numbers in south-east England, east Yorkshire, the north and west Highlands, the Hebrides and the Northern Isles. In these, and some other areas of Scotland (for example Perthshire and Aberdeenshire), declines have occurred over the last ten years.

Probable restricting factors: illegal killing, environmental pollutants, probably habitat deterioration due to overgrazing.

Sparrowhawk

Pre-1900 occurrence: always widespread, surviving Victorian killing better than many other raptors.

UK low point: by 1960, virtual disappearance from eastern arable districts, and reductions in numbers elsewhere due to organochlorine pesticides.

Recovery: since the restrictions on the use of organochlorine pesticides in the late 1960s and 1970s, the sparrowhawk population has been recovering, increasing in numbers and reoccupying most of its former range. However, having peaked in the late 1980s, sparrowhawk numbers in five intensively studied areas (Berkshire, Northamptonshire, Northumberland and two in southern Scotland) have since declined by at least 30%, whilst the rate of carcasse submission has also declined nationally by 50% between 1995 and 1997(Newton *et al.* 1999). The smoothed CBC index has declined by -5% between 1994 and 1998 (BTO unpublished).

Probable restricting factors: decrease of prey species on farmland.

Montagu's harrier

Pre-1900 occurrence: probably always a rare summer visitor as Britain is on the edge of its range.

UK low point: single figures from 1850 to 1920 due to illegal killing, and temporarily absent in the 1970s.

Recovery: recovered to 30 nests in 1953, then declined until none bred in the UK in 1974 and 1975; bred again in 1976, the maximum since being 12 nests in 1990.

Probable restricting factors: human disturbance and agricultural operations as it often nests in cereals; shooting of wintering birds outside the UK.

Honey buzzard

Pre-1900 occurrence: probably always a rare but widely distributed breeding bird.

UK low point: possibly extinct between 1900 and 1910 due to illegal killing.

Recovery: due to protection; the small British population is at the edge of the species' range, with a population of at least 10-30 pairs for many years. More recent evaluations suggest an estimate of possibly 50-60 (Roberts *et al.* 1999).

Probable restricting factors: unknown but likely, in this migratory species, to operate outside the UK, *e.g.* shooting on migration in southern Europe.

Merlin

Pre-1900 occurrence: numerous throughout the British moorlands from south-west England to Shetland.

UK low point: around 550 pairs, between the 1950s and the early 1980s, probably due to organochlorine pesticides, loss or deterioration of habitat and past illegal killing.

Recovery: in 1983-1984, the first large-scale survey of merlins estimated 550-650 pairs (Bibby & Nattrass 1986). A national survey in 1993-1994 (Rebecca & Bainbridge 1998) estimated a population of 1,300 + 200 pairs, which may partly reflect better coverage and partly a moderate recovery.

Probable restricting factors: unknown but likely to be linked to reduced food supply due to loss and ecological deterioration of upland breeding habitat.

Species not previously regionally extinct

Kestrel

Pre-1900 occurrence:	numerous throughout Britain.
UK low point:	became scarce in cereal areas of eastern England during the early 1960s due to organochlorine pesticides; recovery during the 1970s appears to have been followed 15 years later by new declines in range, particularly in north-west Scotland.
Population:	the kestrel is the commonest bird of prey in the UK, distributed throughout the British Isles except Shetland, and some remote mountain areas in north-west Scotland. Recent Common Birds Census and Breeding Bird Survey data (Bashford *et al.* 1999) indicate a significant (-18%) population decline in lowland England, and perhaps Wales between 1994 and 1998. The smoothed CBC index has declined by -23% between 1972 and 1998 (BTO unpublished).
Probable restricting factors:	unknown but likely to be linked to a decline in prey availability due to ecological deterioration of lowland farmland habitats through agricultural intensification; unknown factors in the north and west.

Hobby

UK low point:	during the first half of this century the population was estimated as stable at 60-90 pairs.
Population increase:	since the 1968-1972 estimate (Sharrock 1976) of 100 pairs (which may well have been an underestimate), numbers have grown substantially (estimated in 1997 to be 500-900 pairs) and range has continued to spread northwards.
Probable restricting factors:	no serious factors apparent.

Annex 5: JNCC/Scottish Office literature review specification

Review of current knowledge on aspects of raptor ecology

Background

The Department of the Environment (DoE) held a meeting on 24 April 1995 to discuss the implications of the growth of raptor populations on red grouse and racing pigeons as a direct result of heightened lobbying of the government by pigeon racing and moorland interests. After this meeting Mr Atkins MP, then Environment Minister, announced on 8 June, in response to a Parliamentary Question, that the government would establish an annual Forum and a Working Group to allow various interest groups to discuss issues relating to raptors in the UK, and to work towards resolving problems.

The Working Group was established in September 1995, and was set up with the intention of encompassing the range of interests involved in the raptor issue through key representative organisations. It is chaired jointly by DoE and the Joint Nature Conservation Committee, and its membership consists of the British Association for Shooting and Conservation, Institute of Terrestrial Ecology, Royal Pigeon Racing Association, Royal Society for the Protection of Birds, Scottish Landowners Federation, The Game Conservancy Trust, The Scottish Office and The Scottish Raptor Study Groups. The remit of the working group is outlined in the Terms of Reference which are:

(i) consider population status of birds of prey;

(ii) identify species alleged to be causing problems;

(iii) identify in particular, the impact of such species on game birds and moor land management, and on racing pigeons;

(iv) identify gaps in research, and future needs, and identify possible sources of funding;

(v) consider statutory and other mechanisms for the resolution of problems;

(vi) report back to the forum within one year.

The first Term of Reference is achievable through collating existing scientific data, whilst the second can be addressed through opinion research including questionnaire surveys. However, our understanding of raptors and their interactions with, and impacts on, grouse and racing pigeons at present is insufficient to resolve the current raptor predation issues. The group must now address the third and fourth Terms of Reference by first identifying what has currently been resolved and what areas need to be improved.

To assist the Working Group in this task, a synthesis of facts is required that reviews what is known about red grouse management, pigeon racing and predation by raptors. This would provide a basis for identifying future research requirements that would help clarify the impact of raptors on red grouse and racing pigeons, and thereby allow the Working Group to proceed to the fifth Term of Reference that involves consideration of options for the amicable resolution of the issues.

In addition, there is a wide range of interests and backgrounds represented within the Working Group. Consequently, each member may not necessarily share the same level of experience in each specialised field, be it raptors, red grouse or racing pigeons. A literature review is therefore important to update all members before decisions are taken on future actions.

Outputs

The review will address, *inter alia*, the following questions:

1 Principles of predator control

(a) What is the effectiveness of predation control by:
predator removal
supplementary feeding
taste aversion

(b) Has use by these methods proved to be sustainable in ameliorating predation?

2 Red grouse

(a) What are the reasons for historical and recent changes in population size and distribution of red grouse and hen harriers in Great Britain?

(b) How does habitat management affect the population size of red grouse and hen harrier?

(c) Can different forms of habitat management/red grouse harvesting be used to offset natural predation by hen harriers?

(d) What is known about the impact of raptors on red grouse populations?

3 Racing pigeons

(a) Is there any monitoring of racing pigeon numbers and distribution in Great Britain?

(b) What information exists on losses during races and training?

(c) What evidence exists to suggest that peregrines have an impact on racing pigeons?

(d) What mortality factors of racing pigeons have been identified, in addition to predation by raptors?

4 Feral pigeons

(a) What is known about feral pigeon ecology?

(b) Is there any monitoring of feral pigeon population in Great Britain?

(c) Are there any interactions between feral and domestic populations?

(d) Are feral pigeons controlled? If so, how and under what circumstances?

5 Other species

(a) What is the role of raptors in the population dynamics of birds, other than red grouse and racing pigeons?

(b) Does this interaction change with different prey population sizes and predator population sizes?

(c) What is thought to be the causes in the decline of our common song bird populations?

(d) Has predation by raptors been implicated in any of these declines?

Outputs

The review will provide a concise summary of the key data and issues relating to the questions indicated above. It will summarise both published and main unpublished (*e.g.* limited circulation reports) sources of scientific data and information, and will highlight any gaps where knowledge is insufficient to answer questions posed. The report will be structured in five parts as indicated above and will include a bibliography of sources.

Executive summary

Impacts of raptor predation on red grouse, homing pigeons and songbirds in Britain

Unpublished contract report from the Institute of Terrestrial Ecology to JNCC and SOAEFD

Hinsley, S & Redpath, S 1996

The effects of predation on any population depend on the extent to which predation is offset by reductions in other losses or by improved reproduction. In theory, some bird populations could withstand heavy predation yet maintain their breeding numbers. To reduce breeding or post-breeding numbers, at least part of the predation experienced must be additive to other losses.

In experiments, the removal of corvid and mammalian predators usually led to improvements in nest success of target species. In 12 out of 17 experiments this was followed by increased post-breeding numbers, and in 10 out of 16 experiments, by increased breeding numbers (up to two-fold). These experiments were on species thought to be especially vulnerable to predation but most did not include removal of raptors. The extent of predation was influenced by quality of nesting cover and availability of alternative prey.

Alternative methods of predation control have sometimes led to increased hatching success of avian prey species, but no longer-term effects have been monitored.

Over the past 50 years, the total area of heather moorland in Britain has greatly declined, as a result of afforestation, increased grazing pressure and other land-use changes. Many areas of remaining moorland are in various stages of degradation, again through excessive grazing pressure, so that their carrying capacity for grouse is reduced. On good condition heather moor, greater bags of grouse can be obtained by controlling the main legally-controllable predators (mainly crows and foxes), and the diseases louping ill and strongylosis.

Where foxes and crows were controlled, summer predation by Hen Harriers in one study reduced post-breeding grouse populations by an average of 17%, and by implication may therefore have also reduced the numbers that could have been shot. Winter predation, mainly by foxes and Peregrines, probably reduced subsequent breeding density in one study, but not in another.

Excessive grazing pressure from sheep, and more locally Red Deer, is probably a major underlying cause of decline in Black Grouse and Capercaillie numbers in Britain through reducing chick food supplies and hence survival. Wet weather in June also reduces breeding success in Black Grouse and Capercaillie, and may interact with food-supply.

Over much of their range in Britain, Peregrines depend largely on pigeons, feral and domestic, and remains of ringed birds are often found at eyries. Overall, such pigeons probably form 50% of the Peregrine diet in summer, but considerably less in winter.

One estimate suggests that Peregrines might kill each year a combination of homing and feral pigeons equivalent in number to a maximum of 3% of the homing pigeons owned by British pigeon fanciers. It is impossible to judge what proportion of the homing pigeons that are killed represent a genuine loss to the fancier, as opposed to birds which are otherwise lost or worthless. Regardless of predation, total losses during individual races have been estimated at 10-20%, occasionally larger.

The numbers of feral pigeons in Britain are unknown, but at least within cities they are limited by the food supply. Culling has had no more than temporary local effects on numbers. In rural areas the species could form an important component of Peregrine diet, especially in winter, and help to sustain Peregrines in their present numbers.

Spatial and temporal correlation between songbird declines and Sparrowhawk recovery is poor. Detailed long-term studies of Great Tit, Blue Tit and other woodland bird populations, that were exposed to heavy year-round predation from Sparrowhawks, revealed no measurable impact of hawk predation on prey breeding numbers.

Agricultural intensification, since the 1950s, has caused massive declines in the food supplies of most farmland bird-species. In most species that have been studied in detail, declines in numbers have been attributed primarily to declines in food supplies, for chicks or adults. In two species, declines were attributed to agricultural operations themselves.

Annex 6: DETR red grouse research project

Executive summary

The influence of moorland management on grouse and their predators

Contract report from the Game Conservancy Trust and the Institute of Terrestial Ecology to DETR

Smith, A, Redpath, S & Campbell, S 1999

1 The aim of this study was to examine the influence of moorland management on grouse and their predators. The study was based on desktop literature reviews and the collection of original data on study sites throughout upland Britain. Data were collected between 1997 and 1998 on managed grouse moors. Data on habitat grouse abundance, grouse productivity and passerine abundance were collected. Game Conservancy Trust data on grouse bag, predator bag, indices of predator abundance and parasites were also included in some analyses.

2 Heather moorland has a low diversity of flora and fauna. However, this habitat is of international importance because of the extent and unusual assemblages of species present. Heather dominated moorland is maintained by human activities, principally burning and domestic grazing. 34 bird species breed in upland moorland, of which seven are listed by the EC Birds Directive (six of these species are raptors). Only red grouse, merlin and hen harrier are closely associated with heather cover. A literature review suggested that the abundance of grouse predators is mostly determined by the abundance of their main prey.

3 Red grouse abundance and productivity was not related to heather cover on the heather dominated sites we studied. However, data from additional sites with little heather cover indicated that grouse densities are lower where heather is scarce. The location of the study sites in England or Scotland, altitude and heather nutrient content explained 47% of the variation in spring grouse density. Most grouse were found on sites in England, at low altitudes and with high heather phosphorus content. Grouse productivity was higher on sites with higher July temperatures, greater heather phosphorus content and more cotton grass.

4 Red grouse bags have declined significantly in Scotland over the last 50 years but not in England. Over the last 11 years grouse densities on count areas have not declined. More foxes and crows were killed in England, where keeper density was higher, than in Scotland. More crows were seen on English moors and more fox scats found on Scottish moors. Region, worm burden, louping ill and fox scat abundance explained 60% of the variation in grouse density and region, keeper density and louping ill explained 41% of the variation in grouse productivity. Within England heather nutrient content explained more of the variation in grouse density and productivity than the other measured variables. Within Scotland keeper density, louping ill and fox scat abundance were the most important variables. It is speculated that regional benefits of high keeper density in England may account for some of this difference between England and Scotland.

5 Previous work from six managed moors suggested that meadow pipit and vole abundance influenced the density of breeding harriers. We found that pipit densities at Langholm were not unusual compared to other sites across upland Britain. The ratio of heather to grass cover and heather burning explained 37% of the variation in meadow pipit numbers across sites. Meadow pipit abundance was lower where heather dominated grass on sites within Langholm moor and between extensive sites. These data and those collected on voles suggest that, over the long term, changing moorland habitat to favour heather cover and reduce grass cover may reduce pipit and vole abundance and hence the density of breeding harriers.

6 A literature review found that the nesting success of gamebirds and ducks was influenced by the surrounding habitat. A study of red grouse nesting in 1988 showed that grouse nested in heather taller that that which was available and that nesting success was correlated with vegetation height and density at nests. A radio-tracking study indicated that habitat in the grouse home range explained little variation in overwinter grouse survival. In the summer, harriers attacked more grouse broods in areas with a mixture of grass and heather than expected from the proportion of broods in that habitat.

7 The data presented in this report suggest that grouse densities were only affected by heather cover when heather was scarce, but the nutrient content of the heather did explain some of the variation in grouse density and productivity (Chapter 3). Predator abundance and parasite presence were also correlated with grouse density and productivity (Chapter 4), bur the relative benefits of good habitat, predator and parasite control can only be teased apart through experimental manipulation. The way moorland is managed can have an important bearing on predator density. Notably the ratio of heather to grass and the amount of heather burning appeared important in determining pipit abundance which was in turn correlated with harrier breeding density (Chapter 5). There was some evidence that grouse clutch and brood vulnerability was influenced by vegetation characteristics and thus by moorland management (Chapter 6). Overall the findings suggest that habitat may well influence the relationship between grouse and their predators through effects of habitat on grouse numbers, effects of habitat on predator numbers and effects of habitat on grouse vulnerability. Experimental manipulations are now required.

Annex 7: DETR pigeon research project

Executive summary

A study into the raptor predation of domestic pigeons *Columba livia*

Contract report from Hawk and Owl Trust to DETR and DoENI

Shawyer, C, Clarke, R & Dixon, N 1999

This investigation has established that in Britain and Ireland there are about 75,500 pigeon fanciers. The majority (72,500) belong to clubs involved either in pigeon racing or in the endurance or performance sports involving special breeds of pigeon such as Tipplers, Tumblers and Rollers. Of all the Domestic Pigeons *Columba livia* involved in the different types of pigeon sport, only 0.5% compete in the endurance and performance sports and therefore the sport is mainly related to racing pigeons.

The sport of pigeon racing is organised by five major Unions, the Royal Pigeon Racing Association (RPRA), North of England Homing Union (NEHU), Scottish Homing Union (SHU), Welsh Homing Pigeon Union (WHU), Irish Homing Pigeon Union (IHU) and a sixth smaller Union, the North West Homing Union (NWHU). All of these are recognised members of the Confederation of Long Distance Pigeon Racing Unions of Britain and Ireland.

Excluding the Republic of Ireland, the sport involves just over 69,000 members operating from an estimated 52,000 lofts and managing 3.8 million birds per annum which are both trained and raced. Membership of the sport has been declining steadily at almost 2% per annum over the last 15 years.

Pigeon racing is divided into two racing seasons. The first, between April and July involves 'old birds' which were bred in previous years, followed from July to September by 'young birds' which involves pigeons bred earlier the same year.

The average loft in the UK was shown to house 46 'young birds' and 27 'old birds' destined to compete in their respective race seasons. Lofts also contained a small number of additional pigeons, mainly 'old birds' used as breeding stock and the partners of race birds (mainly hens). These birds were usually confined within their lofts, or in the vicinity for occasional exercise, and as such experience few of the environmental hazards faced by those which compete.

Losses occurred in both 'young' and 'old bird' race teams, from many and varied causes. Losses took place at the loft, during training and racing. In the UK losses of 'young birds' from all causes amounted to 27% in their pre-race period to July and an additional 48% during their racing season, equivalent to an overall loss of 62%. Losses of 'old birds', which start racing as soon as the season begins in April, amounted to 35%. Collectively, the annual losses of Racing Pigeons in the UK totalled 52%.

It has been established that a significant proportion of these losses (42%), could be attributed to straying. This exhibited itself in pigeons taken to wildlife centres suffering from exhaustion and starvation, recruitment into feral flocks and birds from lofts in the eastern half of England displaying acute westerly drift, predation being an eventual outcome. It was further revealed that ringed Racing Pigeons constituted 3.6% of the feral flock population in urban environments.

Collision with overhead wires and solid objects, including vehicles, represented a major cause of loss (40%). Other significant, but lesser causes, involved being shot, entangled, oiled and poisoned.

The age structure of 'old birds' in both the feral flocks and the casualties admitted to wildlife centres, showed no significant differences to the live loft population of Racing Pigeons in the UK. This indicated that pigeons two years old or more were just as likely as yearlings to be recruited into feral flocks or fall victim to various hazards including predation. Predation by raptors mainly involved Sparrowhawk *Accipiter nisus*, Peregrine Falcon *Falco peregrinus* and Goshawk *Accipiter gentilis*.

Sparrowhawk attacks were reported as being carried out mainly by female birds and took place at or near the loft. Although attacks were reported in every month of the year the majority (70%) occurred between March and June (before the onset of the 'young bird' racing season), after which time the majority of breeding female Sparrowhawks are confined to their nests. Attacks at the loft by Sparrowhawks occurred throughout the UK and accounted for an annual collective loss of 2.7 'young' and 'old' birds per loft, equivalent to 3.7% of the Racing Pigeon population in the UK. There was a highly significant difference between areas in the proportions of losses with greater proportions lost in Northern Ireland (4.6%) and Scotland (3.5%), than in Central and Southern England (1.2%).

Goshawk predation on Racing Pigeons was shown to occur most commonly in the spring. Pigeons can be captured in flight or on the ground but very rarely at the loft. Because of the low population size and patchy distribution of Goshawks in the UK, predation is localised. Where this occurs, losses from UK lofts are unlikely to represent more than 0.5% of the Racing Pigeon population.

The Area of Eastern England was used as a control to investigate the losses due to predation and scattering of Racing Pigeons by Peregrines. In this Area both loft and race routes rarely coincide with Peregrine territories. Losses in other Areas of the UK were compared with the control in an attempt to determine those losses due specifically to Peregrines.

In the UK as a whole, about 13 million Racing Pigeon prey opportunities are presented to 3,800 Peregrines throughout the 22-weeks of racing. Numbers peak during the first week-end in August when almost one million pigeons are liberated into the sky above the UK.

Losses caused by Peregrines accounted for 4.2% and 3.2% of the loft populations of 'young' and 'old' birds' during their respective racing seasons. When pigeons from lofts in Eastern England, which are rarely exposed to Peregrines, were excluded from these calculations, loft losses amounted to 7.1% and 7.0%. There was a highly significant difference between Areas, in the proportions of both 'young' and 'old birds' lost to all causes, with Northern Ireland and Scotland experiencing the greatest losses of between 15 and 20%.

The rings of Domestic Pigeons (all types) which were recovered from Peregrine nest sites, following clearances of old rings from eyries prior to April, were used to examine the life-histories and recent flight-histories of pigeons preyed upon by Peregrines. This revealed that attacks by Peregrines were confined mainly to pigeons following their liberation in races (72%) rather than those in training flights or at the loft (28%). There was however a highly significant difference between the Western Area, Eastern England, Scotland and Northern Ireland in the proportions of pigeons involved in these three pursuits (racing, training, or at the loft), which were lost to Peregrines. Of those pigeons lost to Peregrines (4.2% 'young' and 3.2% 'old birds'), the Western Area experienced the greatest proportional losses from the loft (15%), Northern Ireland from training (48%) and Eastern England and Scotland from racing (80% and 95%). It was concluded that in Northern Ireland and the Western Area a greater number of lofts were situated close to Peregrine territories, large numbers of which were located at inland quarry sites. This made pigeons in these two Areas proportionately at greater risk during training or exercising near their lofts.

Race-feral pigeons, (those which had been liberated a year or more before their rings were found in an eyrie), constituted 36% of the Racing Pigeons which were subject to predation by Peregrines in the UK. Of the remainder (those liberated during the year that their rings were found), 46% were flying on a direct line to their lofts, 41% were off-line of their racing/training route and 12% had overshot their loft when they were preyed upon.

It was concluded that 70% of the Racing Pigeons which had been subject to predation by Peregrines was either a consequence of having already adopted a feral existence or having strayed significantly from their racing or training routes. The remainder (30%) of pigeons taken by Peregrines were on a direct line to their loft and were more likely to have arrived home if they had not been subject to predation.

Analysis of the timing of predation showed that the start of the 'old bird' racing season coincided with the laying date (last egg date) for Peregrines and finished soon after their young had fledged. Examination of the liberation dates of the individual pigeons that were caught indicated that predation rates increased rapidly in the first week of May around the hatch period and remained at a fairly constant level through to the end of June at the time when the young vacated their nest ledges.

Comparison of the colours, sex and age structure of the pigeons preyed upon by Peregrines showed no significant difference compared to the live loft population of Racing Pigeons. It revealed that within the 'old bird' sample, pigeons which were two years old or more were proportionately just as likely to be subject to predation as yearlings. This suggested that Peregrines were not selecting pigeons by virtue of their age, colour or sex but simply in proportion to their relative abundance.

There was also no indication that pigeons in long distance races were any more vulnerable to attack than those undertaking short distances. Neither was there any suggestion that birds of good quality (those which had previously won races and were from good race stock) were at less risk than those which had no wins to their credit.

This study indicates that straying or the inability to home, is the major cause of Racing Pigeon losses in the UK. It has also shown that the majority of pigeons which stray from their race routes do so during calm conditions or when there is a light breeze, when pigeon flocks are more likely to fly at similar altitude. This could suggest that clashing (the mixing of groups of pigeons flying in different directions leading to some going off course) is the most likely reason for this phenomenon.

Although this investigation showed that there were no obvious Racing Pigeon characteristics which made particular pigeons more vulnerable to attack than others, it appeared to show a very noticeable trend, particularly in Scotland and Northern Ireland, that pigeons racing on the Natural System were especially prone. Because straying appears to be an important underlying reason for Peregrine predation it could suggest that the Natural System is in some way favouring this unwanted tendency to stray.

Fanciers racing birds on the Widowhood System appear to have a much higher level of return success and the fact that these systems are designed to heighten the keenness of pigeons may simply mean that they are less easily diverted

from their racelines rather than that they actually possess any anti-predation attributes.

Although it is estimated that about 7.5% of Racing Pigeons are lost to raptors per annum in the UK, overall losses to all causes are about 52%. Failure to home or straying appears to be a significant underlying reason for this high level of loss.

The main recommendations are that:

1 high priority is given to researching the reasons for the straying phenomenon. If this can be understood and addressed it is likely to provide the most significant and immediate benefit to the sport in reducing Racing Pigeon losses;

2 in an attempt to reduce predation by Peregrines, it is suggested that the 'old bird' racing season is postponed five weeks to the third week-end in May so that it no longer coincides with the start of the Peregrine's breeding season. This has the potential to reduce predation levels by lowering the breeding success and hence the population size of Peregrines, particularly in areas where they are largely dependent on Racing Pigeons as prey;

3 where possible race routes are optimised to maximise flying times in east England thereby minimising exposure to Peregrines (already being trialled by the SHU);

4 race routes are reorganised in an attempt to establish flight corridors and reduce the current complexity of north/south and east/west 'crossovers'. The current system has the potential to cause pigeons flying in different races to clash and divert from their intended race lines, especially during calm or light wind conditions;

5 more work is undertaken to establish if the Widowhood System has the potential to reduce Racing Pigeon losses, especially from straying, in short, middle and long distance races;

6 undertake rigorous research trials with for example, eye spot deterrents on Racing Pigeons and at lofts, particularly in those regions most vulnerable to Peregrine and Sparrowhawk attack such as south east and north west England, central Scotland and Northern Ireland;

7 in an attempt to reduce the predation risk, examine a sample of lofts in regions of high Sparrowhawk density to determine why, in terms of their aspect/design *etc.*, some experience significant levels of attack while others do not; and

8 where practical, optimise the locations (*i.e.* away from woodland), timing and the numbers of pigeons set free on training tosses as a means of reducing Sparrowhawk attacks at this time and Peregrine attacks en route to the home loft.

Annex 8: Release pen research specification

Raptors and the rearing of pheasants – problems and management needs

Introduction

The recent survey of BASC gamekeepers revealed widespread problems in lowland game management arising from the attention of several raptor species particularly in and around Pheasant release pens (Harradine *et al.* 1997). It revealed also that game managers are using a variety of preventative and deterrent measures to reduce the problems with varying but generally low levels of success. The frustrations caused by this inability to resolve the problems encourage the use of illegal measures.

There is an urgent need to assess the effectiveness of the legal measures available, improve it where possible, and provide practical advice to game managers to help them deal with their problems satisfactorily. This is required for two main reasons. Since gamebirds in release pens are regarded in law as comprising livestock then the licensed killing or taking of otherwise protected birds of prey causing damage to them is an option available to those so troubled. In turn this requires clearer definition of what constitutes "serious damage" to such livestock as well as clear understanding of the effectiveness of the different legal methods of preventing raptor damage in and around pheasant release pens. Resolving these aspects of the raptor/release pen problem, in turn, should reduce both the problems themselves and the use of illegal measures against raptors.

Accordingly a study is proposed to address and help resolve these problems.

Aim of study

To improve the effectiveness of management techniques to minimise losses of young Pheasants caused by raptors in and around Pheasant release pens.

Its specific objectives are:

- to determine the actual losses of Pheasants to raptors both within and around release pens on a sample of shooting estates;
- to determine the losses of Pheasants to other predators or by other means as a result of the attention of raptors in and around the release pens;
- to assess the raptorrelated losses of young Pheasants from release pens in relation to total losses from all sources;
- to assess the economic and other consequences of the losses of young Pheasants to raptors to the game management interests of the estates;
- to determine the relative effectiveness of different deterrent and other management techniques in and around the Pheasant release pens in reducing the attentions of raptors;
- to assess the costeffectiveness of each of those techniques; and
- to provide advice to game managers on the best techniques to minimise problems from raptors in and around Pheasant release pens.

Approach

A sample of widely distributed shooting estates will be selected from lowland Britain which experience regular problems in relation to their Pheasant release pens from at least the following raptors: Sparrowhawk, Tawny Owl, Buzzard and Goshawk.

Within these estates will be identified three representative classes of release pen with respect both to size and pheasant stocking density, to cover the range widely used throughout the country, in the event that size and stocking density are factors affecting raptor attention.

Each of these three types of release pen on the estates will be duplicated, either by matching existing pens on the same site or by building new ones alongside. In year one of the study, one of each of the paired pens will be allocated one of a series of raptordeterrent "treatments" which will include: cover (natural or artificial ground cover and roosting provision), hangers (hanging fertiliser bags etc.), lights/mirrors etc., and noise generators. These are the main types of preventative/deterrent measures widely used against raptors. The other pen of each pair, the control, will not use any special raptor deterrent measures. The allocations will be such that at least three of each type of pen are subject to the same treatment over the sample of estates.

At each study site the habitat types and broad characteristics and other relevant variables, such as public access, will be recorded to provide a basis for identifying other factors which may influence the occurrence, extent or impact of raptor attention on pheasant release pens.

In year two the treatments and controls with respect to each pair of pens will be reversed. Ideally in the third year, the effect of combining treatments in at least a subsample of paired release pens will be measured.

An alternative approach is to operate the sample of paired release pens such that, at each site, the treatment pen becomes the control and the control the treatment half way through the season. This approach should have the merit of reflecting more closely the relationship between pen management and the local population of raptors within each season.

The raptor populations of each estate will be identified and monitored by experienced observers before and during the study. The numbers, health and fate of the pheasant poults within and immediately around each release pen will be monitored by the relevant gamekeepers on the estates, with the cause of any deaths/losses being identified wherever possible. This will be conducted each season, before and during the period, broadly mid-July to the end of August, when pheasant poults are put into and then progressively released from the pens.

In this way it should be possible to determine the effectiveness or otherwise of each of the main types of preventative/deterrent measures, alone and in combination, against the main raptor species creating problems. The approach should also gain information on the influence of release pen size and/or Pheasant numbers on the risk of problems. Furthermore, the whole study will provide new and detailed information on the losses of Pheasant poults from and around release pens to the raptors most blamed for such losses, and, in relation to total losses, on the real impact of such losses to shooting estates. It will also provide the basis for determining the cost-effectiveness of the different measures and the practical advice for game managers to enable them to address the problems they are experiencing in an effective and satisfactory way.

Outputs

A scientific report will be produced at the end of the study giving its findings and recommendations. A specific guide will subsequently be produced, giving practical advice to game managers on measures to manage problems arising from raptors in and around pheasant release pens.

Resources

The estates needed for the study will be identified from the BASC's gamekeeper membership. Materials would be needed in order to create the paired system of release pens. Where possible existing pens and equipment will be utilised. The Pheasant poults will be those produced by each estate.

The main requirement is for a study co-ordinator to set up and manage the study, undertake and supervise, respectively, the monitoring of both raptor s and pheasants, and collate and analyse the results into report form at its completion. Given that release pens are used only during the period, approximately, from midJuly to the end of August, there is clearly only a seasonal co-ordinating requirement for the study's implementation. This need might best be met by contracting an appropriate institution on a seasonal basis, to ensure all elements of the study are undertaken correctly and with the necessary degree of consistency. There will also be travel and subsistence costs as well as costs for data analysis and report production.

The study is likely to cost up to £92,000 over three years with an approximate annual breakdown of: Year 1 £45,000, Year 2 £19,000 and Year 3 £28,000.

Reference

Harradine, J., Reynolds, N. & Laws, T. 1997. *Raptors and Gamebirds a survey of game managers affected by raptors*. BASC, Rossett.

Annex 9: Summary of Scottish Raptor Groups' review of illegal persecution

In the 1950s and 1960s, birds of prey (raptors) were scarce in Britain as a result of past persecution and the effects of pesticide pollution. Through the 1970s and 1980s raptors increased as a result of the combined effects of special protection and the alleviation of pesticide poisoning. However, despite legal protection the killing of raptors continues, including the poisoning, shooting and trapping of full grown birds and the destruction of nests and their contents leading to recent population decline in some areas.

The present document uses data from the files of the Scottish Raptor Study Groups to give examples of the scale and widespread nature of such human interference. Where the data are sufficiently detailed, we quantify the levels of impact by comparing breeding performance and numbers in places where raptors are apparently unmolested with places where human interference has been shown to occur.

In Southeast Scotland human interference occurred at both lowland and upland Peregrine breeding sites, but particularly at those on or adjacent to moorland managed for grouse shooting. At the lowland sites, recorded human interference involved the robbing of about one fifth of breeding attempts with an estimated loss of 19% of the production of young. At grouse moor sites, we recorded nest robbing, nest destruction and/or the killing of adults in about half of nesting attempts resulting in the loss of at least 33% of potential production of young. Taking into account the reduced occupancy of sites, the estimated loss was 52%. At other upland sites, human interference involved nest robbing in about a third of first nesting attempts resulting in an estimated loss of 3% of overall production. In the whole study area, human interference was probably responsible for the loss of about 27% of potential production in the years 1990-96.

At Peregrine nests in Northeast Scotland human interference was involved in failures at 8-22% of nesting attempts each year up to 1991, and has continued since. It was frequent on two estates leading to the loss of about 74% of the production of young. On two estates persecution was less frequently recorded and was probably responsible for a loss of 12% in production. Persecution remained unrecorded on three other estates. The overall loss of breeding production in the area attributable to persecution was at least 24%. No account could be taken of losses due to lowered occupancy or reduced population recovery resulting from low production and the killing of full grown birds.

In Central Scotland, each year a similar number of Peregrine sites were checked on keepered and unkeepered ground. There was little difference in the pattern of occupancy of these sites but a large difference in their productivity, those on keepered ground producing 38% fewer young than those on unkeepered ground. This was not because keepered ground was particularly poor in food (there was little difference in the fledged brood sizes there) but was due to the large number of breeding attempts that failed completely at six sites, suggesting intensive human interference with a third of Peregrine pairs in keepered areas. Were this the case, human interference was affecting about one fifth of the Peregrine breeding population in Central Scotland, reducing overall production by about 18% from 1981 to 1996.

In the Highland Council area, there is circumstantial evidence of the effect of poisoning on the distribution of breeding Golden Eagles. Illegal poisoning in the northern half of Badenoch and Strathspey coincides closely with a conspicuous lack of breeding eagles in suitable habitat that has held nesting pairs in the past. A similar gap in Golden Eagle distribution occurs in East Sutherland where there have also been recent cases of poison abuse. It is likely that between 10 and 20 Golden Eagle ranges are affected.

In Tayside, the breeding performance of unmolested Golden Eagles in 15 ranges was high. Performance was lower at three ranges due to egg robbing, and poorest at 14 ranges where other human interference (poisoning, trapping and shooting) occurred and at five ranges on moorland managed for Red Grouse. On the basis of breeding performance figures for unmolested ranges (0.42 young/range/annum in the west and 0.80 in the east) we might have expected on average 21.6 eaglets to fledge in the Tayside ranges each year, but average production was 12.3, about 43% less.

In Northeast Scotland, 21 Golden Eagle ranges have been monitored. Fifteen are on ground mainly managed for deer and are relatively successful (0.64 young/range/annum, 1990-96). The remaining six are on ground managed for Red Grouse with some plantation forestry and have poor production (0.26 young/range/annum, 1990-96). Here there was intermittent occupancy by Golden Eagles in immature plumage, poisoning and nests destroyed, but at three ranges persecution has apparently ceased with pairs surviving to breed successfully. Assuming that all ranges could produce 0.64 young/range/annum, an average of 13.4 eaglets would have fledged each year from the 21 ranges in the area, but existing production of 11.2 eaglets was 17% less. Within the existing population there are also gaps where there is suitable habitat, suggesting that at least 2 more breeding pairs could exist if the population were allowed to build up.

In Argyll, the occupancy of Golden Eagle ranges was high and success reasonably good but some persecution occurred. In South Argyll over a 25 year period, up to 3 of 19 ranges suffered persecution in any one year. Had such human interference not taken place we would have expected 7% more successful breeding attempts (equivalent to 19 more eaglets fledged) during this time. This is a minimal figure as only known instances of persecution were used; suspected instances were not included nor were those ranges where pairs have disappeared.

On three moors in Southwest Scotland, Hen Harrier breeding success and/or numbers increased after persecution ceased. Such increase was at odds with trends on managed grouse moors elsewhere, where harriers were formerly present. By 1996, there was decline (in places virtually to extinction) in part of the Outer Isles, in the Ladder Hills and the Cabrach/Fiddich/Glass area (Grampian) and in Kincardineshire.

The results are discussed briefly, an Appendix catalogues examples of the persecution of Golden Eagles in Tayside and another details persecution at a communal roost of Buzzards and Ravens.

Annex 10: Joint Raptor Study summary

Birds of prey and red grouse

Redpath, SM & Thirgood, SJ

1 The objective of this study was to examine the impact of raptor predation on red grouse numbers. The study was based at Langholm in south-west Scotland, but was also extended, in part, to five other study moors elsewhere in Scotland. On these moors raptors were protected and numbers of foxes and crows were controlled by gamekeepers. Each year during 1992-1996, we estimated on each moor the abundance of grouse, songbirds and small mammals, and monitored the number, breeding success and diet of hen harriers and peregrines. At Langholm we also studied grouse mortality and raptor hunting behaviour, in addition to measuring a number of habitat features. Finally, we examined records of grouse bags to see how the number of grouse shot changed in the presence of breeding raptors.

2 By the use of aerial photographs, we estimated that 48% of heather-dominant vegetation was lost from Langholm moor between 1948 and 1988, mostly at lower altitudes. This loss of heather and consequent increase in grass was attributed to heavy grazing by sheep. Grouse bags on the same moor have shown a consistent and significant downward trend since 1913 and have also shown six-year fluctuations with the last peak in 1990. Given that raptor breeding densities were thought to be very low before 1990, it is extremely unlikely that raptors were responsible for either the long-term decline or the fluctuations in grouse bags.

3 On four study moors, the average density of breeding harriers increased year-on-year for four years following protection from suspected illegal killing and other interference. During 1992-96, harrier numbers at Langholm increased from 2 to 14 breeding females. Peregrine numbers were generally more constant over time, although at Langholm numbers increased from 3 to 5 or 6 pairs. From October to March, the numbers of peregrines and harriers seen varied considerably between geographical areas. At Langholm, a similar number of peregrine sightings were recorded each winter, but sightings of female harriers fluctuated in line with grouse density.

4 In each year, raptor predation in spring removed on average 30% of the potential breeding stock of grouse, and in the summers of 1995 and 1996 harrier predation removed on average 37% of grouse chicks. Most of these adult and chick losses were probably additive to other forms of mortality, and together reduced the post breeding numbers of grouse by an estimated 50% within a single breeding season. In each year, raptors also killed on average 30% of the grouse between October and March, but it was not possible to determine what proportion of these grouse would have survived in the absence of raptors. A simple, mathematical model of the grouse population at Langholm, combining the estimated reduction in breeding productivity with observed density dependence in winter loss, predicted that over two years, in the absence of breeding raptors, grouse breeding numbers would have increased by 1.3 times and post-breeding numbers would have increased by 2.5 times.

5 Over the course of the study, we found no evidence that predation on adult grouse at Langholm was directly influenced by any of the habitat features we measured. However, a greater proportion of harrier attacks on grouse broods occurred in areas with a mixture of heather and grass, as opposed to pure heather or pure grass stands, than expected from the proportion of grouse broods located by us in that habitat.

6 Throughout the study, the grouse density on Langholm moor in July averaged 33 per 0.5 km^2 and this did not change significantly from year to year and throughout was insufficient to support economically viable shooting. Grouse bags did not peak in 1996 as expected from past records. In contrast, grouse bags on two other nearby moors, which had previously fluctuated in synchrony with those at Langholm, increased to high levels in 1996. These moors held only low densities of raptors. Predation by much larger numbers of raptors at Langholm was considered the most likely explanation for the continued low grouse density and low grouse bags on this moor during the study period. Bags on other moors where raptors were protected did not exhibit the same pattern as observed at Langholm. This was either because raptor numbers remained at low density of because driven shooting was already not viable by the time raptor protection occurred.

7 Breeding densities of harriers and peregrines varied considerably between different moors and were not primarily related to grouse densities. The highest breeding densities of harriers occurred on moors where meadow pipits and small mammals were most abundant. These prey appeared to prefer moors with a high ratio of grass to heather. Peregrine breeding densities were lower in the Highlands than in the north of England, probably because of differences in the abundance of pigeons, their main prey. Extrapolating from data on harrier and

peregrine diet, we judge that the impact of raptor predation will be greatest on moors with grouse densities below approximately 12 pairs per km². This is more likely to be the case on southern rather than northern moors and on moors with a high ratio of grass to heather.

Annex 11: Moorland Working Group activities

Action for Scotland's moorlands: a statement of intent

We recognise:

(i) the conflicting pressures on moorland management;

(ii) the importance of the moorland resource in Scotland's uplands and its major contribution to Scotland's diverse range of landscapes, and biodiversity;

(iii) the changes in upland use in recent decades, and the resulting pressures on moorland management;

(iv) the contribution of properly conducted field sports and game conservation towards the maintenance and enhancement of the natural heritage, and towards rural employment.

We seek a strategic framework to support viable employment in hill farming and in grouse moor management. In addition to their traditional roles, we seek to develop and enhance the conservation of the whole countryside and its biodiversity.

Together we shall strive to:

- work together to maintain and improve the moorland landscape and its wildlife, including the management of the land for all types of grouse shooting;
- oppose all illegal practices, not least the persecution of birds of prey, and encourage adherence to wildlife and countryside legislation;
- contribute positively to any reviews of policies and legislation which may impact on moorland management;
- develop initiatives which raise the awareness of nature conservation issues and natural heritage management practices among moorland managers;
- promote a better understanding of the role and importance of good moorland management practices in conserving the range of species and habitats on moorland.

Next steps

In 1998 and 1999 we shall:

- support the management trial at Langholm, to reduce in the short term the impact of birds of prey on the red grouse harvest, and work towards restoring the heather cover to help provide a long-term solution;
- develop a joint programme of demonstrations and training events to share knowledge and experience in moorland management;
- seek greater investment in sustainable land management practices in the uplands in order to create greater employment opportunities in rural areas.

Signatory Moorland Working Group members:

Game Conservancy Scottish Research Trust
Game Conservancy Trust
Royal Society for the Protection of Birds
Scottish Landowners' Federation
Scottish Natural Heritage

Other Moorland Working Group members:

Scottish Executive

Supporting Organisations:

British Association for Shooting and Conservation
The Heather Trust
National Farmers' Union of Scotland
Royal Institution of Chartered Surveyors in Scotland
Scottish Association for Country Sports
The Scottish Gamekeepers Association
Scottish Raptor Study Groups
Scottish Wildlife Trust
World Wide Fund for Nature