

FORUM

Hen harriers and red grouse: science, politics and human–wildlife conflict

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Summary

1. Human–wildlife conflict is an emerging issue in global conservation. The expansion of human activities throughout the world, combined with restoration of wildlife populations, has led to increased contact and greater conflict between people and wildlife.

2. The mitigation of human–wildlife conflict requires ecological research, social research, and dialogue between scientists, stakeholders and policy-makers to guide management. However, conflict mitigation may be politically sensitive, particularly when legal issues are involved and human livelihoods are at stake. In such cases, political pressures may override scientific evidence.

3. Conflicts over predator management are particularly revealing about the roles of science and politics in the mitigation of human–wildlife conflict. We focus in detail on one well-studied conflict between raptor conservation and grouse management in the UK. Research has demonstrated: (i) there is widespread illegal killing of raptors; (ii) raptor predation can limit grouse populations and reduce hunting revenues; and (iii) mitigation techniques are available but are either unacceptable to stakeholders or unproven in the field.

4. Despite the scientific advances, mitigation of this conflict has been slow. We explore the scientific, political and social barriers to finding a sustainable solution. We suggest that the entrenched positions of stakeholders are the main barrier to progress. We propose a way forward that, if successful, would lead to a win–win situation for raptor conservation and grouse management.

5. *Synthesis and applications.* The mitigation of human–wildlife conflict requires evidence-based management. Scientific evidence is insufficient, however, if the political will is lacking to find solutions. Mitigation of the conflict between raptors and grouse requires both natural and social science research and the recognition that compromises are required to achieve sustainable solutions. These lessons apply equally to human–wildlife conflict situations elsewhere.

Key-words: conflict, economics, grouse, moorland, predation, raptors, stakeholders

Introduction

Human–wildlife conflict is a hot topic in conservation (Macdonald & Service 2007). The expansion of human activities throughout the world, combined with the restoration of wildlife populations, has led to increased contact between people and wildlife (Woodroffe *et al.* 2005a). Increased contact often leads to increased conflict, whether over crop-raiding, predation of livestock and game, or the injury or death of people (Thirgood, Woodroffe & Rabinowitz 2005). The recognition that wildlife can cause significant economic losses to rural

communities, thus undermining local support for conservation, has stimulated much recent research. This research has primarily had a natural science focus and the ecology of some conflicts is now well understood (Woodroffe, Thirgood & Rabinowitz 2005b). By definition, however, human–wildlife conflict involves people, and an understanding of stakeholder attitudes, beliefs and values, together with dialogue between the main actors, is essential in mitigating conflict (Redpath *et al.* 2004). Human–wildlife conflict often extends into the political arena as management decisions are debated by stakeholders. Our aim here is to highlight the role of natural science, social science, stakeholder attitudes and the political dimension in human–wildlife conflict mitigation and to explore some of the barriers to achieving solutions.

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Conflicts between people and wildlife arise for a range of reasons but those involving predators often create the most controversy, possibly because predators generate strong views from stakeholders (Kruuk 2002). Livestock depredation is globally the most common source of human-wildlife conflict and can involve a variety of taxa including felids, canids, ursids and raptors (Thirgood *et al.* 2005). Predation on game species by raptors is an increasing source of conflict, particularly in Europe where hunting is economically significant (Valkama *et al.* 2005). A range of technical approaches to reduce predation have been developed (Breitenmoser *et al.* 2005) in addition to policies to reduce conflict such as zoning (Linnell *et al.* 2005) and financial incentives (Nyhus *et al.* 2005). Lethal control may be considered to be a necessary component of conflict mitigation even when endangered species are involved (Treves & Naughton-Treves 2005). Targeted lethal control may reduce conflict that cannot be resolved in other ways, and perhaps more importantly, may engender public support by acknowledging the impacts that wildlife has on local people. In some cases, if non-lethal techniques are effective enough to reduce conflict to acceptable levels, then the lethal control 'tool' can remain in the conflict resolution 'tool-box' without being used (Woodroffe *et al.* 2005b).

Here we explore these controversial issues through examination of the conflict between the conservation of hen harriers *Circus cyaneus* (L.) and the management of red grouse *Lagopus lagopus scoticus* (Latham) in the UK (Thirgood *et al.* 2000a). We have chosen this conflict for several reasons. First, the ecology of the conflict has been studied in detail. Second, a number of potential mitigation techniques are available. Third, the human dimensions of the conflict have also received attention – albeit only recently. Fourth, fora for stakeholder dialogue have been established. Despite this background, progress 'on-the-ground' to mitigate conflict has been slow. We examine the issues surrounding the mitigation of this conflict, explore the reasons for slow progress, and suggest a way forward to achieve a sustainable solution.

The evidence base

The conflict between harrier conservation and grouse management occurs on the heather moorlands of the UK. Heather moorland is a globally rare habitat largely restricted to the UK and its conservation significance is primarily due to the bird populations it supports (Thompson *et al.* 1995). Half of the UK's heather moorlands are managed by private land-owners for grouse shooting. Management for grouse entails burning heather and controlling predators and parasites. Grouse management is recognized as providing ecological, social and economic benefits (Fraser of Allander Institute 2001; Robertson, Park & Barton 2001; Tharme *et al.* 2001). Predator control traditionally was extended to all avian and mammalian predators of grouse and had profound effects on many species, including harriers (Newton 1979). Although protected under UK legislation since 1952, the illegal killing of harriers on grouse moors is the principal factor limiting

population growth (Etheridge, Summers & Green 1997; Sim *et al.* 2007).

Harriers are killed on grouse moors because hunters believe that they reduce grouse harvests. Scientific research provides support for this view. We studied harrier-grouse dynamics during 1992–1997 on six Scottish grouse moors including detailed demographic research at Langholm in the Scottish Borders (Redpath & Thirgood 1997; Thirgood & Redpath 1997). Harrier breeding densities were related to the abundance of passerines and rodents rather than grouse, and the impact of harriers varied spatially and temporally (Redpath & Thirgood 1999). When harriers attained high breeding densities, there was convincing evidence that their predation limited grouse populations and reduced shooting bags (Thirgood *et al.* 2000b,c). The reduction in grouse harvest resulted in the closure of a commercial shoot valued in 1996 at ~£100 000 per annum (Redpath & Thirgood 1997). These results indicated that genuine conflicts existed between raptor conservation and grouse management (Thirgood *et al.* 2000a).

Several approaches to reduce conflict between harriers and grouse have been suggested (Thirgood *et al.* 2000a; Thirgood & Redpath 2005; Supporting Information Table S1). Some, such as financially compensating hunters or encouraging the release of hand-reared grouse are thought to be politically, financially or logistically unfeasible (Thirgood & Redpath 2005). Others, such as manipulating habitat to reduce the susceptibility of grouse to predation or to reduce the densities of harriers, are either not supported by the available science (Campbell *et al.* 2002; Thirgood *et al.* 2002; Amar *et al.* 2004), or could have negative impacts on biodiversity (Thirgood *et al.* 2000a; Smith *et al.* 2001). Two potential mitigation techniques, in our view, merit serious consideration.

Diversionsary feeding, where harriers are provided with carrion, can reduce provisioning rates of grouse chicks to harrier nests sevenfold (Redpath, Thirgood & Leckie 2001). However, there is currently no evidence that diversionsary feeding leads to increased grouse densities, and this has contributed to reluctance amongst hunters to adopt the technique. There are also concerns that feeding will result in increased densities of harriers and other predators, although there is no evidence for this occurring during field trials (Redpath *et al.* 2001).

More controversial is the suggestion that densities of harriers should be legally limited. One option favoured by some conservationists is to encourage the recovery of golden eagles *Aquila chrysaetos* on grouse moors in the expectation that they will suppress harrier density (Fielding *et al.* 2003). Although plausible, there is little evidence at present to support this approach (Thirgood, Redpath & Graham 2003), and there are challenges in implementation, not least because eagles are also illegally killed on grouse moors (Whitfield *et al.* 2007). Having decided that it is desirable to limit harrier density, a pragmatic approach may be for direct intervention rather than reliance on intra-guild predation. This idea is not new – Potts (1998) suggested a 'quota' scheme where moors would support a given density of harriers and breeding attempts above this would be prevented by translocation.

Harrier quotas were opposed by conservationists, and a UK Government working group established to consider the management of raptors concluded that legal obstacles prevented the implementation of this approach (UK Raptor Working Group 2000).

Research on human–wildlife conflict is often conducted by ecologists and, until recently, the harrier–grouse conflict has been no exception. Conflicts involve people, however, and knowledge of the values and attitudes of stakeholders in a conflict situation is arguably as important as an understanding of the underlying ecology. Multi-criteria analysis was used to evaluate the perspectives of two groups of stakeholders – hunters and conservationists – and to assess their attitudes towards conflict mitigation options (Redpath *et al.* 2004). Whilst both groups recognized the value of grouse moors, the stakeholders differed in their favoured mitigation techniques. Harrier quotas were preferred by hunters whilst conservationists preferred allowing harriers to attain natural densities. Both groups believed that diversionary feeding could be a valuable technique, albeit as part of a suite of mitigation measures (Redpath *et al.* 2004). Quantitative surveys based on semi-structured interviews support these findings, but highlight regional differences in the acceptability of mitigation techniques (Marshall, White & Fischer 2007).

Barriers to progress

The study underpinning this debate was first published in 1997 (Redpath & Thirgood 1997; Thirgood & Redpath 1997) – a 10-year anniversary that stimulated this paper. Whilst there have been a number of scientific publications in the ensuing decade, it is worth asking what has happened ‘on the ground’ to reduce the conflict. Following the publication of this research, Scottish Natural Heritage, the government agency responsible for conservation in Scotland, established the Moorland Working Group as a stakeholder forum to address raptor–grouse conflicts. The Moorland Working Group, and its successor, The Moorland Forum, have commissioned several research projects to investigate mitigation techniques. The first of these was the field test of diversionary feeding described above (Redpath *et al.* 2001). A desk study has assessed the potential for increasing grouse populations through artificial rearing, concluding that it is not feasible (Naylor, White & Mougeot 2005). A second desk study reviewed the impact of raptor predation on bird populations (Park *et al.* 2005). Finally, after several years of negotiations, the Langholm Moor Demonstration Project commenced in 2008 to attempt to restore grouse populations at Langholm, through the use of habitat management, legal predator control and diversionary feeding of harriers.

Harriers are rare breeding birds in England, where illegal killing on, and adjacent to, grouse moors has limited the population to fewer than 20 breeding females (Sim *et al.* 2007). English Nature and its successor Natural England, the English government agency responsible for conservation, initiated a Hen Harrier Recovery Project in 2002. This project monitored harrier breeding attempts and helped to coordinate

an initiative against wildlife crime, but has been unable to improve the conservation status of harriers in England. More encouragingly, stakeholder dialogue has recently been facilitated by The Environment Council, an NGO with experience in conflict resolution. The specific purpose of this dialogue is to explore ways of mitigating the raptor–grouse conflict.

Despite these various initiatives, illegal killing of harriers on grouse moors is widespread and is thought to be responsible for observed declines in harriers in areas associated with grouse shooting (Sim *et al.* 2007). Why has mitigation of the harrier–grouse conflict been so difficult to achieve? Elsewhere in the world, mitigation of human–wildlife conflict has been attained using a variety of social, financial and technical approaches (Woodroffe *et al.* 2005b). We argue that the fundamental barrier to mitigation of the harrier–grouse conflict is the entrenched positions of the major stakeholders. Grouse shooting is a traditional sport and management techniques are often slow to change. Hunters have been slow to recognize that the illegal killing and eradication of protected raptors from large areas of moorland is unacceptable in a modern society where there is strong support for conservation. Encouragingly, recent surveys indicate that hunter attitudes are changing, at least in some regions, and that there is willingness to compromise over raptor management (Redpath *et al.* 2004; Marshall *et al.* 2007).

Entrenched attitudes are not restricted to hunters. Conservationists have consistently refused to contemplate any form of direct intervention to limit harrier densities, citing European legislation which prevents such action. This is understandable in the context of historical persecution of raptors and mistrust between hunters and conservationists. However, the contrast between this approach and the enthusiasm shown by the same conservationists for indirect approaches to limiting harrier densities through intra-guild predation and habitat management is stark. The legal issues concerning derogation from European legislation are too complex for concise discussion here; suffice it to say that lethal control is unacceptable under any circumstances to many conservationists and almost certainly would be legally challenged by conservation NGOs, although it is retained within a ‘tool-box’ of techniques for mitigating conflict with legally protected large carnivores elsewhere in Europe (Linnell *et al.* 2005). Conservation agencies in the UK have promoted a ‘cascade’ approach to mitigation where the least intrusive techniques such as diversionary feeding must be tested conclusively before considering moving towards more intrusive techniques. Whilst conservation agencies and conservation NGOs have stated their support for game management, in our view British conservationists are ambivalent at best about the conservation benefits that hunting can deliver. The reasons for this are complex and worthy of further analysis, but may be related to the intensive nature of game management in the UK, the negative impact that hunters have historically had on predator populations, and the traditional restriction of hunting to the landowning classes.

A further barrier to progress is that of the 'status quo'. Stakeholders in this conflict appear to accept the current situation to varying degrees. Hunters continue to kill harriers and appear prepared to break the law whilst the risk of being caught and prosecuted is slim. Conservation NGOs continue to demand increased law enforcement but such policies have so far failed to reduce the levels of illegal activity. Indeed, it can be argued that NGOs benefit from the publicity that the illegal killing of raptors generates. Conservation agencies establish working groups and commission desk studies rather than face controversy by genuinely striving for conflict mitigation. Scientists benefit because the conflict leads to funding for further research. We are aware that these statements might be considered controversial. Are they justified? That is open to debate but what is indisputable is that harriers continue to be the losers.

A final barrier is money. The research required to underpin conflict mitigation is typically field-based, labour-intensive and expensive. The Langholm Moor Demonstration Project will cost in excess of £3 million over 10 years and will utilize much of the available budgets of the key stakeholders. With this financial commitment, it will be difficult to secure funding for research underpinning alternative approaches to conflict mitigation, as well as for the stakeholder dialogue necessary to ensure that mitigation strategies are adopted.

The way forward

Ten years after the completion of the study that highlighted the conflict between harriers and grouse, how can we move forward? One approach is to continue to focus on law enforcement and rely on prosecution of hunters to reduce the extent of illegal killing of harriers and ultimately eliminate the conflict. We consider that there are strong grounds to question whether this will be effective or sustainable. Law enforcement has so far been ineffective in reducing persecution of harriers and has contributed to the alienation of hunting stakeholders. If increased enforcement were successful and harriers attained 'natural' densities on grouse moors, then given the results of previous research, it is highly likely that a proportion of grouse moors would cease to be economically viable, with negative consequences for the economy of rural areas and moorland biodiversity. We suggest that a more sustainable 'win-win' solution can be achieved which requires progress on two separate fronts. First, a number of outstanding research questions remain about the utility and acceptability of mitigation techniques. Second, stakeholders need to accept that entrenched attitudes will have to change and compromises be made on both sides. We deal briefly with each of these issues below.

A number of outstanding questions about the utility of diversionary feeding need to be addressed (Redpath *et al.* 2001). These include the efficacy of feeding at a range of harrier and grouse densities, the effects of feeding on both harrier and grouse numbers, and the short-term and long-term impacts of feeding on other avian and mammalian predators. It will also be necessary to assess the logistical and financial

inputs required to feed harriers in comparison to other management approaches. Some of these questions will be addressed in the Langholm Moor Demonstration Project. Others require research elsewhere.

Harriers are currently absent as breeding birds from large areas of grouse moorland. We propose a large-scale trial of the feasibility of introducing a ceiling to harrier densities with the aim of encouraging hunters to accept breeding harriers in regions where they are currently illegally killed. The ceiling on harrier densities would be agreed in advance by all stakeholders and would be implemented through translocation of harriers. The trial would test the hypothesis that regional populations of harriers could be increased by setting local ceilings on harrier densities. If successful, this trial could provide a model for increasing the national population of harriers whilst minimizing the local impacts of predation on grouse moors, thus providing a 'win-win' solution for both harrier conservation and grouse management. Translocation of harriers to other areas could also lead to the re-establishment of harrier populations outside the current breeding distribution.

Central to successfully mitigating conflict is an understanding of what is – and conversely what is not – acceptable to stakeholders. Indeed, with hindsight, perhaps the critical shortcoming of the research conducted on harriers and grouse throughout the 1990s was the lack of the human dimension. More recent work has demonstrated that variation exists within stakeholder groups in the acceptability of mitigation techniques (Redpath *et al.* 2004; Marshall *et al.* 2007). This variation occurs both at a regional level, and also in a hierarchical manner, with the views of national organizations not necessarily reflecting the views of individual stakeholders. Both issues require further attention.

Most importantly, we feel that a fundamental change in attitude is required from all stakeholders to resolve the conflict between harriers and grouse. If stakeholders genuinely wish to strive for a solution then compromises will be required and attitudes to predators, their control and their protection, will have to be modified to accommodate changed circumstances. The mitigation of human-wildlife conflict is emerging as a mature sub-discipline within conservation biology and is characterized by a pragmatic approach that incorporates a variety of technical solutions, including at times, lethal control (Woodroffe *et al.* 2005b). Stakeholders within the UK harrier-grouse conflict would benefit from greater discussion and understanding of these international approaches to human-wildlife conflict mitigation. It is hoped that a further 10 years will not be required before progress is made.

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References

- Amar, A., Arroyo, B., Redpath, S. & Thirgood, S. (2004) Habitat predicts losses of red grouse to individual hen harriers. *Journal of Applied Ecology*, **41**, 305–314.
- Breitenmoser, U., Angst, C., Landry, J.M., Breitenmoser, C., Linnell, J. & Weber, J.M. (2005) Non-lethal techniques for reducing depredation. *People*

- and *Wildlife: Conflict and Coexistence?* (eds R. Woodroffe, S. Thirgood & A. Rabinowitz), pp. 49–71. Cambridge University Press, Cambridge, UK.
- Campbell, S.C., Smith, A.A., Redpath, S.M. & Thirgood, S.J. (2002) Nest site characteristics and nesting success in red grouse. *Wildlife Biology*, **8**, 169–174.
- Etheridge, B., Summers, R.W. & Green, R. (1997) The effects of illegal killing and destruction of nests on the population dynamics of hen harriers in Scotland. *Journal of Applied Ecology*, **34**, 1081–1106.
- Fielding, A., Haworth, P., Morgan, D., Thompson, D.B.A. & Whitfield, D.P. (2003) The impact of golden eagles on a diverse bird of prey assemblage. *Birds of Prey in a Changing Landscape* (eds D.B.A. Thompson, S.M. Redpath, M. Marquiss, A. Fielding & C. Galbraith), pp. 221–243. Her Majesty's Stationery Office, London.
- Fraser of Allander Institute (2001) *An Economic Study of Scottish Grouse Moors*. Game Conservancy Scottish Research Trust & Game Conservancy Ltd, Hampshire, UK.
- Kruuk, H. (2002) *Hunter and Hunted*. Cambridge University Press, Cambridge, UK.
- Linnell, J., Nilsen, E.B., Lande, U.S., Herfindal, I., Odden, J., Skogen, K., Andersen, R. & Breitenmoser, U. (2005) Zoning as a means of mitigating conflicts with large carnivores: principles and reality. *People and Wildlife: Conflict and Coexistence?* (eds R. Woodroffe, S. Thirgood & A. Rabinowitz), pp. 162–175. Cambridge University Press, Cambridge, UK.
- Macdonald, D. & Service, K. (2007) *Hot Topics in Conservation*. Blackwell Publishing, Oxford, UK.
- Marshall, K., White, R. & Fischer, A. (2007) Conflicts between humans over wildlife management: on the diversity of stakeholder attitudes and implications for conflict management. *Biodiversity and Conservation*, **16**, 3129–3146.
- Naylor, A., White, R. & Mougeot, F. (2005) *Assessing the Feasibility and Acceptability of Rear and Release, Trap and Transfer and the Use of Dovecotes as Management Options for Red Grouse*. Report to Scotland's Moorland Forum, Edinburgh, UK.
- Newton, I. (1979) *Population Ecology of Raptors*. T+Ad Poyser, London.
- Nyhus, P.J., Osofsky, S.A., Ferraro, P., Madden, F. & Fischer, H. (2005) Bearing the cost of human–wildlife conflict: the challenges of compensation schemes. *People and Wildlife: Conflict and Coexistence?* (eds R. Woodroffe, S. Thirgood & A. Rabinowitz), pp. 107–121. Cambridge University Press, Cambridge, UK.
- Park, K.J., Calladine, J.R., Graham, K.E., Stephenson, C.M. & Wernham, C.V. (2005) *The Impacts of Predatory Birds on Waders, Songbirds, Gamebirds and Fisheries*. Report to Scotland's Moorland Forum, <http://www.moorlandforum.org.uk/documents/PBRFinal.pdf>
- Potts, G.R. (1998) Global dispersion of nesting hen harriers: implications for grouse moors in the UK. *Ibis*, **140**, 76–88.
- Redpath, S. & Thirgood, S. (1997) *Birds of Prey and Red Grouse*. Her Majesty's Stationery Office, London.
- Redpath, S., Arroyo, B., Leckie, F., Bacon, P., Bayfield, N., Gutierrez, R. & Thirgood, S. (2004) Using decision modelling to resolve human–wildlife conflicts: a case study with raptors and grouse. *Conservation Biology*, **18**, 350–359.
- Redpath, S.M. & Thirgood, S.J. (1999) Numerical and functional responses of generalist predators: hen harriers and peregrine falcons on Scottish grouse moors. *Journal of Animal Ecology*, **68**, 879–892.
- Redpath, S.M., Thirgood, S.J. & Leckie, F.M. (2001) Does supplementary feeding reduce harrier predation on red grouse? *Journal of Applied Ecology*, **38**, 1157–1168.
- Robertson, P., Park, K. & Barton, A. (2001) Loss of heather moorland in the Scottish uplands: the role of red grouse management. *Wildlife Biology*, **7**, 11–16.
- Sim, I., Dillon, I., Eaton, M., Etheridge, B., Linley, P., Riley, H., Saunders, R., Sharpe, C. & Tickner, R. (2007) Status of the hen harrier in the UK and Isle of Man in 2004 and a comparison with the 1988 and 1998 surveys. *Bird Study*, **54**, 256–267.
- Smith, A.A., Redpath, S.M., Campbell, S.C. & Thirgood, S.J. (2001) Meadow pipits, red grouse and the habitat characteristics of managed grouse moors. *Journal of Applied Ecology*, **38**, 390–400.
- Tharme, A., Green, R., Baines, D., Bainbridge, I. & O'Brien, M. (2001) The effect of management for red grouse shooting on the population density of breeding birds on heather-dominated moorland. *Journal of Applied Ecology*, **38**, 439–457.
- Thirgood, S. & Redpath, S. (1997) Red grouse and their predators. *Nature*, **390**, 547.
- Thirgood, S. & Redpath, S. (2005) Hen harriers and red grouse: the ecology of a conflict. *People and Wildlife: Conflict and Coexistence?* (eds R. Woodroffe, S. Thirgood & A. Rabinowitz), pp. 192–208. Cambridge University Press, Cambridge, UK.
- Thirgood, S., Redpath, S., Newton, I. & Hudson, P. (2000a) Raptors and red grouse: conservation conflicts and management solutions. *Conservation Biology*, **14**, 95–104.
- Thirgood, S., Redpath, S., Campbell, S. & Smith, A. (2002) Do habitat characteristics influence predation on red grouse? *Journal of Applied Ecology*, **39**, 217–225.
- Thirgood, S.J., Redpath, S., Haydon, D., Rothery, P., Newton, I. & Hudson, P.J. (2000c) Habitat loss and raptor predation: disentangling long term and short term causes of red grouse declines. *Proceedings of the Royal Society Series B*, **267**, 651–656.
- Thirgood, S.J., Redpath, S., Rothery, P. & Aebischer, N. (2000b) Raptor predation and population limitation in red grouse. *Journal of Animal Ecology*, **69**, 504–516.
- Thirgood, S.J., Redpath, S.M. & Graham, I. (2003) What determines the foraging distribution of raptors on heather moorland? *Oikos*, **100**, 15–24.
- Thirgood, S., Woodroffe, R. & Rabinowitz, A. (2005) The impact of human–wildlife conflict on human lives and livelihoods. *People and Wildlife: Conflict or Coexistence?* (eds R. Woodroffe, S. Thirgood & A. Rabinowitz), pp. 13–26. Cambridge University Press, Cambridge, UK.
- Thompson, D.B.A., MacDonald, A., Marsden, J. & Galbraith, C. (1995) Upland heather moorland in the UK: a review of international importance, vegetation change and objectives for conservation. *Biological Conservation*, **71**, 163–178.
- Treves, A. & Naughton-Treves, L. (2005) Evaluating lethal control in the management of human–wildlife conflict. *People and Wildlife: Conflict or Coexistence?* (eds R. Woodroffe, S. Thirgood & A. Rabinowitz), pp. 86–106. Cambridge University Press, Cambridge, UK.
- UK Raptor Working Group (2000) *Report of the UK Raptor Working Group*. Joint Nature Conservation Committee, Peterborough, UK.
- Valkama, J., Korpimäki, E., Arroyo, B., Beja, P., Bretagnolle, V., Bro, E., Kenward, R., Manosa, S., Redpath, S., Thirgood, S. & Vinuela, J. (2005) Birds of prey as limiting factors of gamebird populations in Europe. *Biological Reviews*, **80**, 171–203.
- Whitfield, D.P., Fielding, A., Mcleod, D., Morton, K., Stirling-Aird, P. & Eaton, M. (2007) Factors constraining the distribution of golden eagles in Scotland. *Bird Study*, **54**, 199–211.
- Woodroffe, R., Thirgood, S. & Rabinowitz, A. (2005a) The impact of human–wildlife conflict on natural systems. *People and Wildlife: Conflict or Coexistence?* (eds R. Woodroffe, S. Thirgood & A. Rabinowitz), pp. 1–12. Cambridge University Press, Cambridge, UK.
- Woodroffe, R., Thirgood, S. & Rabinowitz, A. (2005b) The future of coexistence. *People and Wildlife: Conflict and Coexistence?* (eds R. Woodroffe, S. Thirgood & A. Rabinowitz), pp. 388–405. Cambridge University Press, Cambridge, UK.

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Supporting Information

Additional Supporting Information may be found in the online version of this article:

Table S1. Techniques proposed to mitigate conflict between hen harrier conservation and red grouse management and a summary of their utility

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