POLICY PERSPECTIVE

Pheasants, buzzards, and trophic cascades

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Abstract

The partial recovery of large birds of prey in lowland Britain has reignited conflicts with game managers and prompted a controversial U.K. government proposal to investigate ways of limiting losses to pheasant shooting operations. Yet best estimates are that buzzards are only a minor source of pheasant mortality–road traffic, for example, is far more important. Moreover, because there are often large numbers of nonbreeding buzzards, local control of breeding pairs may simply lead to their replacement by immigrant buzzards. Most significantly, consideration of the complexity of trophic interactions suggests that even if successful, lowering buzzard numbers may directly or indirectly increase the abundance of other medium-sized predators (such as foxes and corvids) which potentially have much greater impacts on pheasant numbers. To be effective, interventions need to be underpinned by far more rigorous understanding of the dynamics of ecosystems dominated by artificially reared, superabundant nonnative game species.

The U.K. government's recent proposal and rapid withdrawal of "sublethal" control measures on common buzzard (*Buteo buteo*—hereafter "buzzard") populations to limit losses of ring-necked pheasants (*Phasianus colchicus*—hereafter "pheasants"; Anon 2012) highlight problems of oversimplifying predator/prey relations, especially in highly disturbed ecosystems. Although the widespread (but still incomplete) recovery of raptor populations following past persecution, habitat loss, and pesticide poisoning is one of the greatest triumphs of the U.K. conservation movement, it has also led to the return of conflicts with game shooting operations. Thus, the suggestion by Wildlife Minister Richard Benyon, that measures such as buzzard nest destruction and translocation might be investigated raised the hackles of both conservation NGOs and the wider public, whereas the subsequent cancellation of the tender in turn provoked anger from the Countryside Alliance and other rural stakeholder groups. Here we try to put these proposals to protect pheasant shooting in wider ecological context, examine the available evidence on whether buzzard control might reduce pheasant mortality, and assess possible unforeseen outcomes by considering broader species interactions.

Pheasant mortality

Despite being nonnative, pheasants are, in terms of biomass, by far the most abundant birds in Britain. During 1968–1988, although the total biomass of other British birds fell by ~29%, pheasant numbers rose fivefold to make up over 30% of landbird biomass (Dolton & Brooke 1999). Between 20 and 35 million pheasants are released by the shooting industry annually, adding to wild-bred stocks (PCEM 2006; Park *et al.* 2008). The most thorough field study to date of the fate of 486 reared pheasants found that 37.5% of the birds were shot and

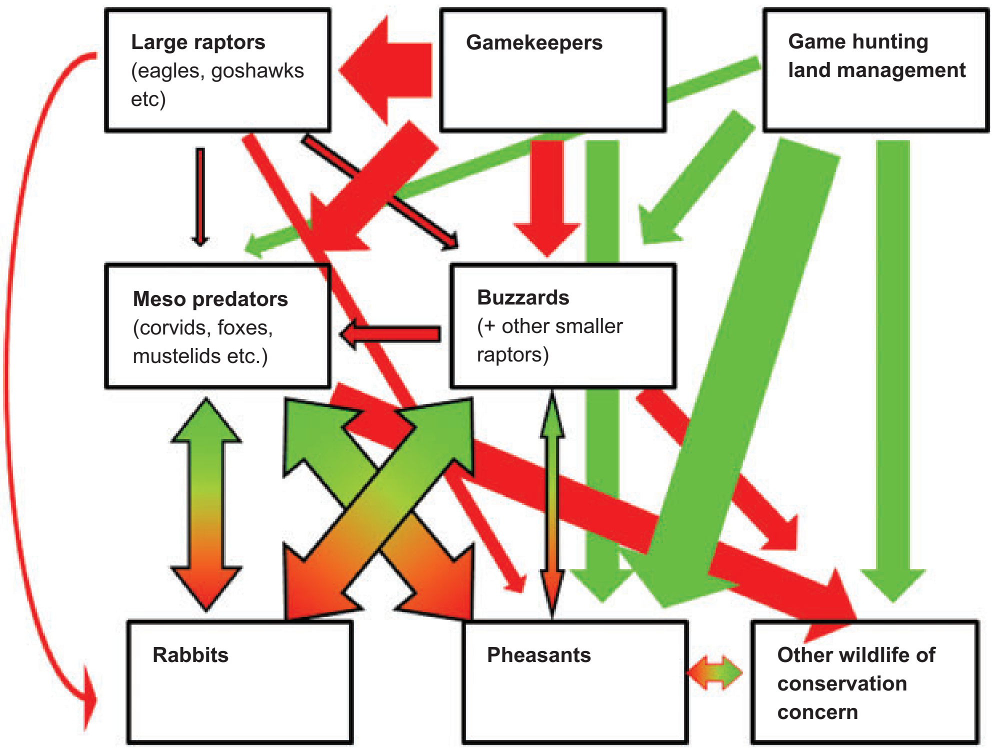

Figure 1 A simplified conceptual map of interspecific interactions involving buzzards, pheasants, and people. Arrow width is roughly proportional to population-level effect size; arrow colour denotes effect on species at arrow tip (red = negative, green = positive, with two-way effects given by two-way arrows). Direct negative impacts of buzzards on pheasants may be more than offset by their predation of medium sized predators (mesopredators) that kill pheasants or predation of rabbits that would otherwise support elevated mesopredator populations. For simplicity, many interactions (such as impacts of vehicles on pheasants and of pheasants on woodland flora and invertebrates) are not shown, whereas arrows for those discussed in the text are marked by a black border. Full reference list for each interaction is provided in the Supporting Information.

36% predated or scavenged—principally by foxes (*Vulpes vulpes*; Turner & Sage 2003). In this study, raptors were implicated in the deaths of <1% of individuals, whereas a detailed study on buzzard predation on pheasants in Dorset that found they kill ∼4% (Kenward *et al.* 2001). A further 5–13% are killed on the roads. In addition to the overlooked economic cost of ∼3 million vehicle collisions each year (e.g., Erritzoe *et al.* 2003; Anon 2008), the resulting subsidy of medium-sized predators through scavenging on roadside carcasses and on unretrieved shot birds (cf. Mason & Macdonald 1995) probably leads to enhanced predation on pheasants and many other smaller birds and mammals (e.g., cf. Ritchie & Johnson 2009; Fletcher *et al.* 2010). These results are comparable to many published European studies which typically report that raptors account for a relatively small proportion of mortality among released pheasants (e.g., Valkama *et al.* 2005; Park *et al.* 2008). Other studies have revealed substantial impacts of other mesopredators, such as foxes and corvids, on game bird numbers (Tapper *et al.* 1991; Fletcher *et al.* 2010).

Policy efficacy

Besides their evidently minor contribution to pheasant mortality, the demography of buzzards raises doubts about the feasibility of reducing predation on pheasants by local-scale nonlethal control. It is estimated that for each paired buzzard in well established populations in southern Britain there are up to three additional nonbreeding birds (Kenward *et al.* 2000). So, even if individuals are prevented from breeding, any buzzards that are translocated (or killed) are likely to be quickly replaced by immigrants from adjacent poorer quality habitats. Two recently prosecuted Shropshire gamekeepers discovered the extent of such immigration for themselves when they illegally killed over 100 buzzards on one estate in less than 6 months (Evans 2008). A more promising approach to reducing buzzard predation lies in making pheasant release pens less accommodating as raptor hunting grounds—by encouraging shrubs rather than ground cover, by locating pens where there are few perches for buzzards, and perhaps by higher density releases

(Kenward *et al.* 2001). Research into such preventative measures formed part of the abandoned proposal and would appear potentially fruitful for all concerned.

Trophic interactions

Practicalities aside, consideration of trophic interactions shows that the notion that a single predator species can straightforwardly lower the availability of game prey for human hunters (and that this can be prevented by removing predators) is a gross simplification (see Figure 1; Yodzis 2001; Estes *et al.* 2011). Although buzzards may have a minor negative impact on game populations by direct predation, this may be more than compensated by buzzard predation on other predators such as corvids which, through nest predation, may have significant impacts on the reproductive success of the wild breeding stock of pheasants (cf. Milonoff 2004). Moreover because buzzards mostly feed on rabbits (*Oryctolagus cuniculus*; which cause agricultural damage reckoned at £180 million annually [Williams *et al.* 2010]), removing buzzards may impose subtle economic penalties on landowners (and not only on those who release pheasants)—as well as leading to increased numbers of foxes, which kill at least four times as many pheasants as do buzzards (despite foxes being controlled). Last, examination of interspecific interactions suggests that limitation of buzzard populations might take place naturally if illegal persecution of apex avian predators is stopped and their full return to lowland Britain encouraged. Persecution of many raptor species continues to limit their population expansion into parts of their former range (e.g., Newton 1979; Etheridge *et al.* 1997; Smart *et al.* 2010). Such apex predators may exert considerable influence on community structure through top-down control; species such as golden (*Aquila chrysaetos*) and white-tailed eagles (*Haliaeetus albicilla*), goshawks (*Accipiter gentilis*), and eagle owls (*Bubo bubo*) may not only limit buzzard numbers through intraguild predation but also reduce populations of foxes and other medium-sized predators (cf. Sergio & Hiraldo 2008). However, attitudes toward these top predators are still frosty in parts of Britain; for example a recent abandoned proposal to reintroduce white-tailed eagles to East Anglia encountered strong opposition from some rural landowners (e.g., Worthington 2010). Investment in conservation of top avian predators constitutes “trophic upgrading” (cf. Estes *et al.* 2011) which may have concomitant benefits for game hunting and biodiversity targets alike.

Conclusions

Conservationists have voiced widespread concern that the Benyon proposal risked inadvertently greenlighting wider raptor persecution at a time when illegal persecution already looks set to drive hen harriers (*Circus cyaneus*) to extinction in England. By viewing human–predator conflicts through a simplistic one-predator, one-prey lens we suggest that the plan was also ill-conceived scientifically. By ignoring their population biology and interactions with other species, ad hoc local control of predators such as buzzards could just as likely exacerbate losses of pheasants as reduce them. The potential benefits of pheasant shooting to conservation in lowland Britain—through land-management regimes that may be positive for many nongame species—have been extensively reviewed (e.g., Oldfield *et al.* 2003) but neither the impacts of pheasant community monodominance on other wildlife, nor indirect shooting impacts (such as lead shot poisoning or disturbance) have received significant scientific attention. Potential community-level impacts may include competition with other bird species for food resources (Fuller *et al.* 2005), and potential transmission of parasites and pathogens to other sympatric species (e.g., Tompkins 2001, but see Sage *et al.* 2002). In the future, effective game management interventions will require far more rigorous analysis of the ecological, conservation, and economic consequences of maintaining supernormal densities of introduced game species than has been achieved so far.

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Supporting Information

Additional Supporting Information may be found in the online version of this article at the publisher’s web site:

Key references for figure.

References

Anon. (2008) *Post office® counts the cost of wild animal accidents*. www.deercollisions.co.uk/web-content/ftp/PoReleaseMar08.pdf (visited Sept. 6, 2012).

Anon. (2012) *Myth bust: reports that Defra is proposing to cull buzzards*. www.defra.gov.uk/news/2012/05/24/myth-bust-reports-that-defra-is-proposing-to-cull-buzzards/ (visited May 31, 2012).

Dolton, C.S. & Brooke, M.de L. (1999) Changes in the biomass of birds breeding in Great Britain, 1968–88. *Bird Study*, **46,** 274-278.

Erritzoe, J., Mazgajski, T.D., Rejt, Ł. (2003) Bird casualties on European roads—a review. *Acta Ornithol*., **38,** 77-93.

Estes, J.A., Terborgh, J., Brashares, J.S. *et al*. (2011) Trophic downgrading of planet earth. *Science*, **333,** 301-306.

Etheridge, B., Summers, R.W. & Green, R.E. (1997) The effects of illegal killing and destruction of nests by humans on the population dynamics of the Hen Harrier in Scotland. *J. Appl. Ecol.*, **34,** 1081-1105.

Evans, P. (2008) Foul deeds or fair prey? *The Guardian Newspaper*. 15 October 2008. http://www.guardian.co.uk/environment/2008/oct/15/conservation-wildlife (visited May 31, 2012).

Fletcher, K., Aebischer, N.J., Baines, D., Foster, R. & Hoodless, A.N. (2010) Changes in breeding success and abundance of ground-nesting moorland birds in relation to the experimental deployment of legal predator control. *J. Appl. Ecol.*, **47,** 263-272

Fuller, R.J., Noble, D.G., Smith, K.W. & Vanhinsbergh, D. (2005) Recent declines in populations of woodland birds in Britain: a review of possible causes. *Brit. Birds.*, **98,** 116-143.

Kenward, R.E, Walls, S.S, Hodder, K.H, Pahkala, M, Freeman, S.N. & Simpson, V.R. (2000) The prevalence of nonbreeders in raptor populations: evidence from rings, radio-tags and transect surveys. *Oikos*, **91,** 271-279.

Kenward, R.E., Hall, D.G., Walls, S.S. & Hodder, K.H. (2001) Factors affecting predation by buzzards *Buteo buteo* on released pheasants *Phasianus colchicus*. *J. Appl. Ecol.*, **38,** 813-822.

Mason, C.F. & Macdonald, S.M. (1995) Corvids feeding on carrion. *Bird Study*, **42,** 255-256.

Milonoff, M. (1994) An overlooked connection between goshawk and tetraonids—corvids! *Suomen Riista*, **40,** 91-97.

Newton, I. (1979) *Population ecology of raptors*. T. & A. D. Poyser, Berkhamsted.

Oldfield, T.E.E., Smith, R.J., Harrop, S.R. & Leader-Williams, N. (2003) Field sports and conservation in the United Kingdom. *Nature*, **423,** 531-533.

Park, K.J., Graham, K.E., Calladine, J. & Wernham, W. (2008) Impacts of birds of prey on gamebirds in the UK: a review. *Ibis*, **150**(Suppl. 1), 9-26.

Public & Corporate Economic Consultants. (2006) *The economic and environmental impact of sporting shooting*. Commissioned report for British Association for Shooting & Conservation, the Countryside Alliance and the Country Land and Business Association, in association with the Game Conservancy Trust. Cambridge, UK. http://www.shootingfacts.co.uk. (visited May 31, 2012).

Ritchie, E.G. & Johnson, C.N. (2009) Predator interactions, mesopredator release and biodiversity conservation. *Ecol. Lett.*, **12,** 982-998.

Sage, R.B., Woodburn, M.I.A., Davis, C. & Aebischer, N.J. (2002) The effect of an experimental infection of the nematode *Heterakis gallinarum* on hand-reared grey partridges *Perdix perdix*. *Parasitology*, **124,** 529-535.

Sergio, F. & Hiraldo, F. (2008) Intraguild predation in raptor assemblages: a review. *Ibis*, **150,** 132-145.

Smart, J., Amar, A., Sim, I.M.W. *et al*. (2010) Illegal killing slows population recovery of a re-introduced raptor of high conservation concern—the red kite *Milvus milvus*. *Biol. Conserv*., **143,** 1278-1286.

Tapper, S.C., Potts, G.R. & Brockless, H.M. (1991) The effect of an experimental reduction in predation pressure on the breeding success and population density of Grey Partridges *Perdix perdix*. *J. Appl. Ecol.*, **33,** 965-978.

Tompkins, D.M., Greenman, J.V. & Hudson, P.J. (2001) Differential impact of a shared nematode parasite on two gamebird hosts: implications for apparent competition. *Parasitology*, **122,** 187-193.

Turner, C. & Sage, R. (2003) Fate of released pheasants. *Game Conserv. Ann. Rev.*, **35,** 74-75.

Valkama, J., Korpimäki, E., Arroyo, B. *et al*. (2005) Birds of prey as limiting factors of gamebird populations in Europe: a review. *Biol. Rev.*, **80,** 171-203.

Williams, F., Eschen, R., Harris, A. *et al*. (2010) *The economic cost of invasive non-native species on Great Britain*. CABI Publishing, Wallingford. wunconference.files.wordpress.com/2011/08/the_economic_cost_of_invasive_non-native_species_to_great_britain_-_final_report.pdf (visited May 31, 2012).

Worthington, M. (2010) *Sea eagle plan hits turbulence in East Anglia*. www.bbc.co.uk/news/10303266 (visited Sept. 6, 2012).

Yodzis, P. (2001) Must top predators be culled for the sake of fisheries? *Trends Ecol. Evol.*, **16,** 78-84.

