Fletcher, K. et al. 2014.
BOU Proceedings – Ecology and conservation of birds in upland and alpine habitats
http://www.bou.org.uk/bouproc-net/uplands/fletchcer-et-al.pdf

Proceedings of the BOU's 2014 Annual Conference
Ecology and conservation of birds in upland and alpine habitats
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Game management in the UK uplands: a review of the effects of management on other wildlife and ecosystem services

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Game management aims to boost populations of game species to enable sustainable harvesting. Sporting interests in UK uplands include shooting of Red Grouse *Lagopus lagopus scotica* which became popular in the early 1900s, then declined during the world wars and has not returned to these earlier levels. It is estimated that grouse moors make up 5–15% of UK uplands and between 20 and 60% of UK's heather-dominated moorland. Grouse moor management focuses on providing habitat and food through grazing and heather burning, reducing predator pressure, and reducing parasites and disease. There are two shooting styles in the UK depending on the grouse density in that year. At higher densities grouse are driven, where a line of beaters drive the birds over stationary shooters. At lower densities the shooters walk across the moor. Estates can charge twice as much per bird shot for driven shooting, allowing estates to cover costs, which is not possible undertaking walked up shooting only. Grouse moors are beneficial to local rural economy with Scottish grouse moors estimated to support 1072 jobs which is the equivalent of £14.5 million and contributes £23.3million to GDP (Dunlop & Smith 2010). UK wide, grouse shooting contributes £120 million in a good year to the economy, although this figure is due to be updated later in 2014.

Seventy-five per cent of the world's heather is in the UK and grouse moor management has helped stem the decline in this habitat. Scottish estates show that between the 1940s and 1980s where grouse management was retained the percentage heather cover decreased by 10%, but where grouse management was abandoned a 24% decrease in heather cover occurred (Robertson *et al.* 2001). Managed heather burning provides a range of heather ages and if unburnt areas are also left this provides beneficial habitats for a range of taxa. A recent study in the Peak District has shown that the cessation of heather burning leads to heather dominance and lower plant diversity (Harris *et al.* 2011). However, grouse moor management does halt the natural succession to woodland as it focuses on providing open landscapes.

Predator control is a key component of grouse moor management targeting generalist predators such as Red Foxes *Vulpes vulpes*, corvids and small mustelids. Reviews highlight the benefit of reducing predator pressure, particularly on ground-nesting birds. Predator control has also recently been advocated as a management tool to mitigate the negative effects of presence of commercial plantations for Eurasian Curlew *Numenius arquata*, a species on IUCN's list of globally near threatened species and

for which the UK supports up to 25% of the breeding population (Douglas *et al.* 2014). Mountain Hares *Lepus timidus* have also been reported in the past at higher densities on grouse moors benefiting from predator control and habitat mosaics provided by heather burning. Hares are of particular relevance as prey for Golden Eagles *Aquila chrysaetos* but they are also one of the mammalian tick hosts. Ticks, and the disease louping ill that they transmit, have detrimental effects of grouse chick survival so tick management is often undertaken on grouse moors. Tick reduction can be achieved by treating sheep with acaricides, reducing deer by exclusion or culls, and on sites with no deer and sheep management Hare culls were found to reduce tick levels (Laurenson *et al.* 2003). The National Gamebag Census data collated since the 1950s show no long-term trend in Mountain Hares, but as a cyclical species trends can be difficult to quantify and further work is needed to help monitor the effects of management on this species.

In the UK we also have protected predators. Grouse populations are vulnerable to raptor predation when at low points of the cycle (Thirgood *et al.* 2000). Illegal persecution, often attributed to grouse moors, has been found to have population-level effects for some raptor species. To help move forward with this conflict resolution it is important that those involved with grouse moors are involved in collaborative projects, such as the Langholm Moor Demonstration Project and development of conservation frameworks for Hen Harriers *Circus cyaneus*.

The UK's most important carbon stores are deep peat and 70% of UK water comes from uplands. Grouse moors are rare or absent from many of the UK's extensive peat areas, but where grouse moors overlap with deep peat, grip blocking and managed burning may influence carbon flux and water quality although their effects are expected to be complex (see recent reviews by Shepherd *et al.* 2013, Glaves *et al.* 2013). Blocking of drainage channels or grips may increase soil moisture and reduce water yield, reducing the dissolved organic carbon near the drain, but no catchment-level effects have been found. Blocking grips is thought to increase methane emission, but a more consistent water table releases less methane than a fluctuating one, so over the longer term the effect of blocking on methane emission may be neutral. Grip blocking can lead to higher invertebrate abundance and some evidence for increased cover of peat-forming plant species. Overall grip blocking that is done on grouse moors and elsewhere seems to have neutral or positive effects but variation between studies may, at least in part, be due to the method used to block grips and ongoing Defra-funded work is looking at this. Managed heather burning reduces fuel load and creates fire breaks so has the potential to reduce wildlife risk, which will vary regionally and depend on climate and visitor pressure, both of which are expected to increase the prevalence and intensity of wildfire in future. Heather burning does release more dissolved organic carbon during laboratory studies but evidence from plot and catchment studies is contradictory, so effects of heather burning on water quality are less clear. Grouse moors are expected to follow Defra/Scottish Government burning codes which are regularly reviewed to take

account of emerging research. The majority of grouse moors in England also have burning plans agreed with Natural England.

Uplands attract 100 million day visits per year in the UK, with access to nature thought to lead to improvements in physical and mental wellbeing. Walking is increasing with access to natural environments the main motivator. Questionnaires to Scottish public ranked which habitat, plants and animals they felt were important (Stewart 2006). Hills & Mountains (as well as lochs) were the highest ranked habitat, heather was the most important plant and Red Deer *Cervus elephas*/Roe Deer *Capreolus capreolus* the most important animal. Although Red Grouse did not make the top ten for the Scottish public it is clear that the public do value habitats associated with grouse moor management.

Ecosystem services are often split into provisioning, regulating and cultural services. Grouse moors provide provisioning services in terms of grouse and to a lesser extent sheep, they are involved in regulating services in terms of carbon and water, and cultural services in providing iconic landscapes, wildlife, employment and tourism opportunities. Conflict resolution to improve the conservation status of raptors and further research is needed to ensure management is compatible with carbon storage and water quality. Going forward we hope to ensure the benefits of grouse moor management for local rural economies and species of conservation concern are able to continue in this multi-use landscape.

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