

Rewilding and Ecosystem Services



This POSTnote explores the consequences of increasing the role of natural processes within landscapes. Evidence from the UK and abroad suggests that rewilding can benefit both wildlife and local people, but animal reintroductions could adversely affect some land-users.

What is Rewilding?

There is no single definition of rewilding, but it generally refers to reinstating natural processes that would have occurred in the absence of human activity.^{1,2} These include vegetation succession, where grasslands develop into wetlands or forests, and ecological disturbances caused by disease, flooding, fire and wild herbivores (plant eaters). Initially, natural processes may be restored through human interventions such as tree planting, drainage blocking and reintroducing “keystone species”^{3,4} like beavers. In the long term, self-regulating natural processes may reduce the need for human management. Rewilding can have unpredictable outcomes, but it may also represent a cost-effective way to provide ecosystem services (benefits provided by natural processes)⁵ such as flood prevention.⁶ Rewilding might help to reduce or offset negative impacts of intensive agriculture including: soil degradation [[POSTnote 502](#)]; greenhouse-gas emissions [[POSTnotes 453 & 486](#)]; water pollution [[POSTnote 478](#)]; insect pollinator declines [[POSTnote 442](#)] and a reduction in biodiversity (the variety of living things).⁷

This briefing outlines approaches to rewilding land across Europe, as well as the potential benefits and risks involved. Rewilding has not been referred to by the UK government, so it is put into the context of relevant policy on agriculture and biodiversity. While some advocate rewilding of the seas using no-fishing zones,⁸ this is not discussed here.

Overview

- Rewilding aims to restore natural processes that are self-regulating, reducing the need for human management of land.
- Few rewilding projects are underway, and there is limited evidence on their impacts.
- Rewilding may provide ecosystem services such as flood prevention, carbon storage and recreation. It often has low input costs, but can still benefit biodiversity.
- Some valued and protected priority habitats such as chalk grassland currently depend on agricultural practices like grazing. Rewilding may not result in such habitats.
- No government policy refers explicitly to rewilding, but it has the potential to complement existing approaches to meet commitments on habitat restoration.

Rewilding and Current Conservation Practice

UK landscapes have been managed to produce food and wood for millennia, and 70% of land is currently farmed.⁹ €3bn per year is spent on environmental management of farmland across the EU.^{10,11} This includes maintaining wildlife habitats on farmland such as heathland and chalk grassland, which involves traditional agricultural practices such as fire and grazing.^{12,13} Rewilding involves ecological restoration (the repair of degraded ecosystems),¹⁴ and differs from mainstream conservation in two main ways:

- Existing policies promote the conservation of specific endangered species and habitats. Rewilding focuses on restoring natural processes and dynamics, and the groups of species that emerge from this.¹⁵
- Existing practices use active management to increase biodiversity in nature reserves. This may involve low-intensity livestock grazing, but rewilding generally has a long term goal of reduced management by humans.¹⁶

Conflicting Views on Rewilding

Interest in rewilding has increased rapidly in recent years.¹⁵ Some see rewilding as a positive vision for restoring ecosystems,¹⁷ but others feel that it is poorly defined and may result in people being excluded from natural spaces.¹⁸ Rewilding is generally seen as an open-ended approach, but there has been a considerable amount of debate about the type of ecosystem that it should aim to restore (Box 1).

Box 1. Benchmarks for Rewilding

Ecosystems that existed during eras before modern humans have been suggested as benchmarks for rewilding. These eras include:

- **The Eemian interglacial** (between ice ages; 132,000 – 113,000 years before present).¹⁹ This came before large animal extinctions linked to the spread of modern humans.²⁰ In North America and Europe, some propose that the role of now-extinct elephants and lions could be filled by introducing non-native equivalents.^{21,22}
- **The early to mid-Holocene** (10,000 - 5000 years before present). Before widespread settled agriculture, landscapes may have been more forested than at present (but still up to 50% open). This followed extinctions of large animals, which may have previously opened up the canopy.²³

However, restoring land to a historic state is not always possible. Rewilding in human-altered landscapes could lead to the emergence of novel combinations of species,²⁴ and some proponents suggest that rewilding should take inspiration from the past, but not replicate it.¹⁶

Rewilding Methods

Reduced management alone can restore natural processes. It may be done deliberately, as in strict forest reserves with little or no human intervention,²⁵ or unintentionally, as with unprofitable farmland being abandoned across the EU.²⁶ Another example is the halt in human activities in the Chernobyl exclusion zone following the 1986 disaster. However, in other circumstances human interventions may be needed to restore functioning natural processes.

Kick-starting Natural Processes

Natural processes may be kick-started in several ways; for example, where seed sources no longer exist, trees can be planted and fenced off to assist vegetation succession. This is being done at Carrifran and Glen Affric in Scotland.^{27,28} Furthermore, straightened river channels can be “re-meandered” to restore natural flood dynamics upstream [[POSTnote 484](#)]. Reintroductions of carnivores and herbivores can also help to restore natural processes,⁴ as can removal of invasive species such as rats.¹ However, animal reintroductions are not always feasible and some stakeholders argue rewilding can be done without them.²⁹

Carnivore Reintroductions

Thousands of years of large carnivore declines worldwide have had significant ecological effects.³⁰ For instance, hunting of the Eurasian lynx in Finland and Scandinavia caused numbers of red foxes to increase, which led to declines in numbers of the fox's prey and competitor species.³¹ If human pressures diminish then predators at the top of the food chain may recover by default; this happened following Chernobyl with the recovery of wolves.³² Wolf numbers have also increased across Europe more widely, partly because of protective legislation.³³ Reintroductions can also be used to restore predation; for example, the reintroduction of wolves to Yellowstone National Park controlled the numbers and behaviour of American elk. This allowed vegetation succession in some areas and provided benefits for wildlife more broadly.³⁴ In the UK, species-level conservation programmes have reintroduced white-tailed eagles to Scotland³⁵ and boosted pine marten populations in Wales by transferring animals from Scotland.³⁶

Herbivore Reintroductions

Some large wild herbivores, such as aurochs and elk, have been extinct or declining for thousands of years.³⁷ They play

a key role in ecosystem function by distributing seeds and nutrients throughout landscapes in their dung.³⁸ They also play a key role in regulating vegetation succession, for example by grazing grasslands or the leaves of shrubs and trees.³⁹ As with carnivores, herbivore numbers sometimes recover without human intervention when human pressures subside. For example, densities of European elk are at least as high in the Chernobyl exclusion zone as in nearby nature reserves.⁴⁰ Otherwise herbivores can be reintroduced: At the Oostvaardersplassen nature reserve in the Netherlands, introduced heck cattle and konik ponies are intended to fill the role of extinct herbivores such as aurochs and tarpan.⁴¹ In the UK, herbivores have usually been introduced to fenced areas. Many are partially domesticated, although a few elk have been reintroduced at Alladale, Scotland.

Ecological Engineers

Some species are of interest because of how they influence the structure of the environment. For example, beavers cut down trees and build dams that might help prevent flooding (Box 2). Wild boar root around deeply in the soil, disturbing it and preparing it for new vegetation to establish.⁴² In the UK, several breeding populations of wild boar have re-established accidentally,⁴³ and beavers have been reintroduced to rivers in Devon,⁴⁴ Knapdale and Tayside.⁴⁵

Benefits and Risks of Rewilding

There are gaps in the evidence base on the consequences of rewilding. This is partly because projects are scarce; the Rewilding Britain NGO lists 13 key projects on its web site.⁴⁶ In addition, the impacts of existing projects are difficult to gauge without appropriate control data. However, studies of natural processes shed light on the likely benefits and risks.

Benefits*Reduced Management Costs*

The cost of land management is substantial, whether for agriculture, wildlife or other ecosystem services. Over half of total farming income in the UK derives from EU subsidies,⁴⁷ and many farms might not be economically viable without them.⁴⁸ In addition, public spending on conservation in Sites of Special Scientific Interest (SSSI) is around £85 per hectare per year, including payments to landowners for environmental management.⁴⁹ Rewilding approaches can provide biodiversity gains and reduce the need for human management. For example, blocking drains can restore wetland habitats without much further input from people.⁵⁰ Reintroduced animals can have the same effects on habitats as management measures formerly carried out by people; for instance, wolves can control numbers and behaviour of deer and reduce the need for culling.⁵¹

Biodiversity and Recreation

A reduction in human management can lead to an increase in biodiversity. For example, abandoned crop fields at the Rothamsted Experimental Station in Hertfordshire developed into diverse mature woodlands within a century.⁵² At the Knepp Wildland Project, many species benefit from a mosaic of habitats produced through grazing by de-domesticated breeds of herbivores (Box 3). This provides opportunities for recreation; global demand for nature tourism is so high that visits to protected areas generate

Box 2. Beavers as Ecological Engineers in Devon

Beavers create leaky dams in rivers and streams. These cause localised flooding, creating complex wetland habitats that increase beavers' food supply and protect their burrows from predators.⁵³ After rainfall, beaver dams trap sediment and reduce peak flow downstream (Figure 1).⁵⁴ They also filter agricultural pollutants such as nitrates and phosphates.⁵⁵ However, burrowing, tree felling and localised flooding create costs for local land managers. A beaver management strategy has been produced for the River Otter to help mitigate these impacts, with relocation and lethal control proposed as a last resort.⁵⁶

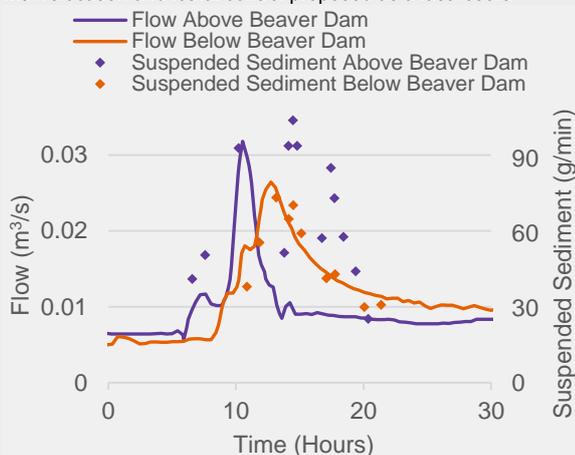


Figure 1. Stream flow and suspended sediment above and below a beaver dam following rainfall at the Devon Beaver Project. Peak flow is lower below the dam and delayed by several hours. Sediment levels are also reduced below the dam, meaning that water was cleaner.⁵⁵

\$600bn in revenue each year.⁵⁷ Rewilding has the potential to increase revenue from tourism, attracting people firstly as a label that is rapidly increasing in popularity,¹⁵ and secondly through opportunities to see charismatic species. For example, White-tailed eagles have become a wildlife spectacle in Scotland, generating up to £5m a year in tourist spending on the Isle of Mull.^{58,59} Ospreys are also a significant tourist attraction on Rutland water in England.

Flood Prevention and Water Quality

Rewilding may have benefits for flood prevention and water quality,⁶ examples include:

- **Wetland restoration.** This can incorporate rewilding approaches; it involves blocking man-made drainage systems and letting habitats develop naturally.⁵⁰ Wetland habitats such as blanket bog retain water and decrease water treatment costs,⁶⁰ so water companies like United Utilities and South West Water invest in restoring them. Wetland restoration is also happening at large scales, such as the Great Fen Project in Cambridgeshire.⁶¹ However, these habitats may also increase prevalence of bog asphodel, a plant that can poison sheep that eat it.⁶
- **River restoration.** Re-meandering rivers can reduce flood risk on land downstream; this is done at the Eddleston water project in Scotland.⁶² The river Liza at Wild Ennerdale in the Lake District is allowed to shift freely in response to heavy rainfall, so it drops lots of sediment before reaching Ennerdale lake.⁶³
- **Vegetation succession.** The Wild Ennerdale initiative has reduced sheep grazing and seeks to increase tree cover through regeneration of native woodland. These factors can result in greater absorption and reduced runoff of water from land, reducing flood risk downstream.⁶⁴
- **Beavers.** Dams built by beavers can reduce peak flows

Box 3. Rewilding at the Knepp Wildland Project

Knepp Castle Estate in Sussex comprises 1,400ha of heavy clay soils, so landowners have struggled to make a profit through arable and dairy farming. Since 2001, all available land has been taken out of production and put into a rewilding project.⁶⁵ It aims to restore natural ecological processes using free roaming herds of grazing and browsing animals as drivers.³⁹ This involved removing internal fences and giving deer and hardy breeds of pigs, cattle and ponies free roam of the estate. The emerging scrub, wood-pasture, water meadows and grassland currently support some of the largest UK populations of Nightingales, Turtle Doves and Purple Emperor Butterflies. The estate has reduced its agricultural input costs, and receives income from organic meat sales and Common Agricultural Policy payments. Furthermore, a new camping and ecotourism enterprise employs three people full time; it had a turnover of £120,000 in the first year, with a profit of £19,000 that looks set to increase in future. Farm turnover under conventional farming was £1.2m with a return on capital of -2% to +1%, whereas today turnover is £1m with return on capital of 5%.

downstream and improve water quality (Box 2).

Greenhouse-Gas Emissions

There are potential benefits of rewilding for GHG emissions. Agriculture contributes 9% of the UK's greenhouse-gas (GHG) emissions, such as nitrous oxide, methane and carbon dioxide and 10-12% globally [[POSTnotes 453 & 486](#)]. Reducing intensive management of farmland through rewilding would be likely to reduce local GHG emissions.⁶⁶ Habitats resulting from rewilding may also have the potential for storage of carbon and nitrogen [[POSTnote 447](#)]. For example, woodlands that developed on former crop fields at Rothamsted store an additional two tonnes of carbon and 20kg of nitrogen per hectare per year, although the amount gained varied between sites.⁶⁷ Restored wetlands are carbon dioxide sinks, but they are also a source of methane [[POSTnote 454](#)].⁶⁸ A recent UK study found that increasing agricultural yields on reduced areas of farmland while restoring habitat on 'spared' land could reduce GHG emissions and keep food prices low.⁶⁹

Risks

Unpredictable Outcomes

Rewilding is likely to lead to an increase in biodiversity, but outcomes are often unpredictable and unique to each site. Many species will benefit from rewilding, but others may decline – especially those that depend on features currently maintained by human intervention. Around 1-in-5 UK butterfly species (18%) inhabit open habitats that result from traditional agricultural practices⁷⁰ and rewilding could lead to different types of habitat.⁷¹ Increasing the scale and interconnectedness of habitats through rewilding may help some species adapt to climate change, but others might fare better where humans continue to intervene.^{72,73} Furthermore, animal reintroductions can have unpredictable outcomes. The IUCN (the world conservation union) have produced guidelines emphasising the need for comprehensive risk assessments and warning against releasing species outside their indigenous range.⁷⁴ An evidence-based framework is needed to select species suitable for reintroduction in any given case.⁴

Attitudes to Reintroductions

Stable or rising populations of lynx, wolves and bears in Europe show that human-predator coexistence is possible.³³

However, range expansions and reintroductions of animals tend to cause conflict between groups of people with different values.⁷⁵ For example, some people enjoy seeing wild boar in UK woodland, but others call for culls to prevent crop damage.⁴³ White-tailed eagles are appreciated by tourists and conservationists in Ireland and Scotland, but they take some sheep farmers' lambs (although some argue that livestock losses are economically negligible).^{58,76} Conflicts can sometimes be avoided by creating consensus management plans for the reintroduction of a species.^{77,78}

Animal Control and Welfare

In the absence of wild predators, ongoing human intervention might be required to control numbers of some animals. Managers at the rewilded Oostvaardersplassen nature reserve faced conflict from animal welfare campaigners over winter mortality of cattle and ponies prevented from moving out of the reserve.⁷⁹ The notion that these animals were "wild" was contested, implying they should not be exempt from animal welfare regulations. Reserve managers were granted exception from animal welfare, but they reached a compromise in which they shot animals deemed unlikely to survive the winter. This compromise continues to face international criticism.⁸⁰

Making Space for Rewilding

Rewilding needs to be reconciled with other forms of land use that benefit people, such as agriculture. Some argue that rewilding of less productive farmland could more than compensate for biodiversity losses on intensively managed crop fields [POSTnote 418]. Compared to Bulgaria, Estonia, Latvia, Poland, Romania, Slovenia and Slovakia the UK has a very limited area that could be described as wilderness,⁸¹ and rewilding could improve this.⁸² Some point to upland areas, where farmers are highly dependent on income support,⁸³ as candidates for rewilding.¹⁷ However, in the case of the Wild Ennerdale project, some upland farmers criticised the changed appearance of the landscape and voiced concerns about the loss of the farming heritage of the region.⁸⁴ The Scottish Highlands is thought to be the main UK region that could support populations of large predators,⁸⁵ with enough woodland and prey to potentially support 400 lynx.⁸⁶ However, at smaller scales, the Rewilding Britain NGO argues that even post-industrial sites in urban areas can be rewilded. They recommend that local communities have ownership of the rewilding process.⁴⁶

Rewilding and UK Policy

No UK government policy or statement refers to rewilding explicitly. However, rewilding is relevant to many policy areas including agriculture, natural capital and biodiversity.

Agricultural Policy

The UK must adhere to the Common Agricultural Policy (CAP) while it remains a member of the EU, and the same level of agricultural support will continue until 2020 regardless of exit from the EU. The CAP forms 40% of EU spending,⁸⁷ and constrains rewilding in three main ways:

- 70% of CAP payments to farmers are conditional on land in "good agricultural condition". Land must be suitable for grazing or cultivation, and free from "ineligible features", such as dense scrub that may arise through rewilding.⁸⁸

- Some CAP payments require livestock grazing. Projects are inclined to use livestock to receive payments, but this may not be the best way of restoring natural processes.⁸²
 - CAP payments raise the market value of marginal farmland; acquiring such land for rewilding is expensive.⁸⁹
- Though a small proportion of CAP funding is spent on environmental protection, some have argued that the CAP fails on biodiversity and non-food ecosystem services.⁹⁰ Policymakers have also suggested that post Brexit landowners could be paid for providing specific ecosystem services, such as flood prevention.⁹¹ Rewilding measures might be applicable to this end. Up to now, rewilding projects such as the Alladale wilderness reserve in Scotland⁹² have been funded by landowners with alternative views on land use. Other projects are supported by crowd-funding; Trees for Life volunteers have paid for and planted over a million trees for rewilding in the Scottish Highlands.²⁸

Natural Capital

Natural capital has been defined as "the parts of the natural environment that produce value to people", such as clean air and water, food, and protection from hazards.⁹³ Preliminary accounts suggest that the UK's natural capital is declining,⁹⁴ and the Government's plan for the natural environment will set targets to address this. The Rewilding Europe NGO suggests that as a complement to existing conservation practices, rewilding can help to create new natural assets.¹⁶ However, this will depend on how benefits from rewilding trade-off with benefits from other land-uses.⁸³

Biodiversity Policy

Rewilding may represent a cost-effective way to restore large areas of degraded habitat and reintroduce native species. However, because of unpredictable outcomes rewilding may not deliver other UK commitments on biodiversity (Box 4). Additionally, some UK legislation may form a barrier to reintroductions. For example, it is illegal to release wild boar in England and Wales.⁹⁵ Ongoing management is likely to be required to meet commitments on weeds or non-native invasive species; even strict forest reserves are managed by people to control rhododendron.²⁵

Box 4. Biodiversity Policy in the UK

Legislative commitments on biodiversity are derived largely from the international conventions including the Bern convention on the Conservation of European Wildlife and Natural Habitats⁹⁶ and the Bonn convention on the Conservation of Migratory Species of Wild Animals.⁹⁷ Key legislation includes the Wildlife and Countryside Act,⁹⁵ Nature Conservation (Scotland) Act,⁹⁸ the Wildlife and Natural Environment Act (Northern-Ireland),⁹⁹ the Environment (Wales) Act¹⁰⁰ and the EU Nature Directives.^{101,102} Legislation:

- Protects priority animals (including most birds), plants and habitats.
- Provides for the SSSI/ASSI (Site/Area of Special Scientific Interest) and Natura 2000 protected area networks to maintain habitats.
- Pledges reintroduction of native species of wild plants and animals if studies show it is effective and acceptable.

The Convention on Biological Diversity¹⁰³ outlines further pledges to restore degraded habitats, and has stimulated the "Biodiversity 2020" strategies for England,¹⁰⁴ Northern Ireland¹⁰⁵ and Scotland.¹⁰⁶

Endnotes

- 1 Lorimer, J, *et al*, 2015, *Annual Review of Environment and Resources*, 40, 39-62
- 2 Navarro, L, and Pereira, H, 2012, *Ecosystems*, 15, 900-912
- 3 Sandom, C, *et al*, 2013, *Key Topics in Conservation Biology 2*, Chapter 23: *Rewilding*, 430-451, John Wiley & Sons Ltd, London

- 4 Svenning, J.-C., *et al*, 2016, *PNAS*, 113, 898-906
- 5 Millennium Ecosystem Assessment, 2005, [Ecosystems and Human Well-being: Biodiversity Synthesis](#), World Resources Institute, Washington, DC
- 6 Carver, S., 2016, *ECOS*, 37, 32-43
- 7 Balmford, A., *et al*, 2012, *Proceedings of the Royal Society B: Biological Sciences*, 279, 2714-2724
- 8 Monbiot, G., 2014, [Feral: Rewilding the land, the sea and human life](#). University of Chicago Press, Chicago, IL
- 9 Defra, 2011, [The Natural Choice: securing the value of nature \(white paper\)](#). London
- 10 European Commission, 2016, [Agri-environment measures](#)
- 11 Whittingham, M., *Journal of Applied Ecology*, 44, 1-5
- 12 Poschod, P., and WallieDeVries, M., 2002, *Biological Conservation*, 104, 361-376
- 13 Webb, N., 1998, *Journal of Applied Ecology*, 35, 987-990
- 14 Hobbs, R., and Harris, J., 2001, *Restoration Ecology*, 9, 239-246
- 15 Jepson, P., 2016, *Ecography*, 39, 117-124
- 16 Jepson, P., and Schepers, F., 2016, [Making Space for Rewilding: Creating an enabling policy environment](#), Oxford/Nijmegen
- 17 Monbiot, G., 2013, [A manifesto for rewilding the world](#)
- 18 Jørgensen, D., 2015, *Geoforum*, 65, 482-488
- 19 Donlan, C., *et al*, 2012, *The American Naturalist*, 168:5, 660-681
- 20 Sandom, C., *et al*, 2014, *Proceedings of the Royal Society B: Biological Sciences*, 281, 20133254
- 21 Donlan, J., 2005, *Nature*, 436, 913-914
- 22 Monbiot, G., 2015, [Thinking Like an Elephant](#)
- 23 Hodder, K., *et al*, 2009, *British Wildlife*, 20(S), 4-15
- 24 Hobbs, R., *et al*, 2009, *Trends in Ecology and Evolution*, 24, 599-605
- 25 European Commission, 2000, [COST Action E4: Forest reserves research network](#), Brussels
- 26 Keenleyside, C., and Tucker, G., 2010, [Farmland Abandonment in the EU: an Assessment of Trends and Prospects. Report prepared for WWF, IEEP](#)
- 27 Ahsmole, M., and Ashmole, P., 2009, [The Carrifran Wildwood Project. Ecological restoration from the grassroots](#), Borders Forest Trust, Jedburgh
- 28 Trees for Life, 2016, [Trees for Life](#)
- 29 Bachell, A., 2015, [SNH position on re-wilding](#)
- 30 Ripple, W., *et al*, 2014, *Science*, 343, 1241-1244
- 31 Ritchie, E., *et al*, 2012, *Trends in Ecology and Evolution*, 27, 265-271
- 32 Shkvryria, M., and Vishnevskiy, D., 2012, *Vestnik Zoologii*, 46, e21-e28
- 33 Chapron, G., *et al*, 2014, *Science*, 346, 1517-1519
- 34 Ripple, W., and Beschta, R., 2012, *Biological Conservation*, 145, 205-213
- 35 Green, R., *et al*, 1996, *Journal of Applied Ecology*, 33, 357-368
- 36 Vincent Wildlife Trust, 2016, [Pine Marten Recovery Project](#)
- 37 Malhi, Y., *et al*, 2016, *PNAS*, 113, 838-846
- 38 Doughty, C., *et al*, 2013, *Nature Geoscience*, 6, 761-764
- 39 Vera, F., 2000, [Grazing ecology and forest history](#), CAB International, Wallingford
- 40 Deryabina, T., *et al*, 2015, *Current Biology*, 25, R824-R826
- 41 Vera, F., 2009, *British Wildlife*, 20(S), 28-36
- 42 Sandom, C., *et al*, 2013, *Restoration Ecology*, 21, 329-335.
- 43 Defra, 2008, [Feral wild boar in England: An action plan. PB 12997](#)
- 44 BBC, 2015, [Devon wild beavers cleared to stay on the River Otter](#)
- 45 Scottish Natural Heritage, 2015, [Beavers in Scotland: A report to the Scottish Government](#)
- 46 Rewilding Britain, 2016, [Rewilding Britain](#)
- 47 Defra, 2015, [Total income from farming in the UK](#)
- 48 National Farmers Union, 2016, [UK Farming's relationship with the EU](#)
- 49 Defra, 2011, [Benefits of Sites of Special Scientific Interest](#)
- 50 Mitsch, W., and Wilson, R., 1996, *Ecological Applications*, 6, 77-83
- 51 Manning, A., *et al*, 2009, *Biological Conservation*, 142, 2314-2321
- 52 Harmer, R., *et al*, 2001, *Biological Conservation*, 101, 291-304
- 53 Naiman, R., *et al*, 1988, *BioScience*, 38, 753-762
- 54 Nyssen, J., *et al*, 2011, *Journal of Hydrology*, 402, 92-102
- 55 Brazier, R., *et al*, 2016, [Quantifying the multiple, environmental benefits of reintroducing the Eurasian Beaver. European Geophysical Union, Vienna, 2016: EGU2016-7243](#)
- 56 Devon Wildlife Trust, 2016, [Beaver Management Strategy. A strategy for addressing the risks associated with a free living beaver population on the River Otter](#)
- 57 Balmford, A., *et al*, 2015, *PLOS Biology*, 13, e1002074
- 58 Marquiss, M., *et al*, 2003 [The Impact of White-tailed Eagles on Sheep Farming on Mull. Final Report. Contract Number: ITE/004/99](#), CEH
- 59 Molloy, D., 2011, [Wildlife at work. The economic impact of white-tailed eagles on the Isle of Mull](#), The RSPB, Sandy
- 60 Grand-Clement, E., *et al*, 2015, *Journal of Environmental Management*, 161, 417-430
- 61 The Great Fen Project, 2016, [The Great Fen Project](#)
- 62 Tweed Forum, 2016, [Eddleston Water Project](#)
- 63 National Trust, 2016, [Wild Ennerdale, Cumbria](#)
- 64 Marshall, M., *et al*, 2014, *Hydrological Processes*, 28, 2617-2629
- 65 Knepp Castle Estate, 2016, [Knepp wildland project](#)
- 66 National Trust, 2012, [What's your beef?](#)
- 67 Poulton, P., *et al*, 2003, *Global Change Biology*, 9, 942-955
- 68 Knox, S., *et al*, 2015, *Global Change Biology*, 21, 750-765
- 69 Lamb, A., *et al*, 2016, *Nature Climate Change*, 6, 1-5
- 70 Thomas, J., 1993, *Ecography*, 16, 278-284
- 71 Kirby, K., 2009, *British Wildlife*, 20(S), 59-63
- 72 Corlett, R., 2016, *Trends in Ecology & Evolution*, 31, 453-462
- 73 Natural England & RSPB, 2014, [Climate Change Adaptation Manual](#)
- 74 IUCN/SSC, 2013, [Guidelines for Reintroductions and Other Conservation Translocations. Version 1.0](#)
- 75 Redpath, S., *et al*, 2015, *Oryx*, 49, 222-225
- 76 O'Rourke, E., 2014, *Land Use Policy*, 38, 129-137
- 77 Arts, K., *et al*, 2012, *Land Use Policy*, 29, 911-920
- 78 Redpath, S., *et al*, 2013, *Trends in Ecology and Evolution*, 28, 100-109
- 79 Lorimer, J., and Driessen, C., 2014, *ECOS*, 35, 44-52
- 80 ICMO2, 2010, [Natural processes, animal welfare, moral aspects and management of the The Oostvaardersplassen. Report of the second International Commission on Management of Oostvaardersplassen \(ICMO2\)](#), The Hague/Wageningen
- 81 Fisher, M., *et al*, 2010, [Review of status and conservation of wild land in Europe. Final Report. CR/2009/31](#), Wildland Research Institute, Leeds
- 82 Carver, S., 2014, *ECOS*, 35, 4-14
- 83 Government Office for Science, 2010, [Foresight Land Use Futures Project: Final Project Report](#)
- 84 Convery, I., and Dutton, T., 2008, *Journal of Rural and Community Development*, 3, 104-118
- 85 Wilson, C., 2004, *Mammal Review*, 34, 211-232
- 86 Hetherington, D., *et al*, 2008, *Mammal Review*, 38, 285-303
- 87 European Commission, 2016, [CAP post-2013: Key graphs & figures](#)
- 88 European Parliament & Council of the European Union, 2013, [REGULATION \(EU\) No 1307/2013 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 17 December 2013 establishing rules for direct payments to farmers under support schemes within the framework of the common agricultural policy and repealing Council Regulation](#)
- 89 Merckx, T., and Pereira, H., 2014, *Basic and Applied Ecology*, 16, 95-103
- 90 Pe'er, G., *et al*, 2014, *Science*, 344, 1090-1092
- 91 House of Commons Library, 2016, [Brexit: impacts across policy areas. BRIEFING PAPER Number 07213](#), House of Commons, London
- 92 BBC, 2013, [Paul Lister plans to push ahead with Alladale wolves plan](#)
- 93 National Capital Committee, 2016, [Natural Capital Committee](#)
- 94 Office for National Statistics, 2014, [UK Natural Capital – Initial and Partial Monetary Estimates](#)
- 95 UK Parliament, 1981, [Wildlife and Countryside Act 1981](#)
- 96 Council of Europe, 1979, [Bern Convention on the Conservation of European Wildlife and Natural Habitats](#)
- 97 United Nations Environment Programme, 1979, [Bonn Convention on the Conservation of Migratory Species of Wild Animals](#)
- 98 UK Parliament, 2004, [Nature Conservation \(Scotland\) Act 2004](#)
- 99 UK Parliament, 2011, [Wildlife and Natural Environment Act \(Northern Ireland\) 2011](#), TSO
- 100 UK Parliament, 2016, [Environment \(Wales\) Act 2016](#)
- 101 Council of the European Union, 1992, [Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora](#)
- 102 European Parliament & Council of the European Union, 2009, [Directive 2009/147/EC of the European Parliament and of the Council of 30 November 2009 on the conservation of wild birds](#)
- 103 Conference of the Parties, 1992, [The Convention on Biological Diversity](#).
- 104 Defra, 2011, [Biodiversity 2020: A strategy for England's wildlife and ecosystem services](#)
- 105 Department of the Environment (Northern Ireland), 2015, [Valuing Nature: A Biodiversity Strategy for Northern Ireland to 2020](#)
- 106 The Scottish Government, 2013, [2020 Challenge for Scotland's Biodiversity - A Strategy for the conservation and enhancement of biodiversity in Scotland](#)