Is the most effective way to increase biodiversity in the UK through conservation management or rewilding?

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Abstract:

This project compares two conservation methods that aim to preserve and enhance biodiversity in the UK. These methods are rewilding and conservation management. Central to both approaches is an understanding of the complex relationships and processes that develop in an ecosystem. To realise the capacity of the landscape theories of the UKs prehistoric past are analysed. This has huge importance for making the right choices of inputs for rewilding projects. The reliability of conservation management is compared with the unpredictability of rewilding. This is illustrated through examples of human dependent habitats and unexpected benefits of current rewilding projects. While rewilding encourages natural ecological change, management restricts and conserves existing relationships. The naturalness of mass exstinction is discussed as an extreme result of ecological change. The ability of ecosystems to adapt and transform shows how change can be both profound and routine, giving support to the rewilding model. In modern society rewilding is hampered by strong business and public interests concerned with the ‘tidiness’ of this method. Political interests further restrict re-introduction of species essential to rewilding projects. Both rewilding and conservation management prove to be effective at increasing biodiversity in different natural and social circumstances.

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Introduction

The concept of 'rewilding' can be interpreted in a number of ways.[1] Theoretically rewilding is the return of an area to its 'natural state' by ecological succession (the change in species structure of an ecological community over time) without human interference. Support for rewilding often comes from the idea that it naturally preserves, or even increases, biodiversity in a given area. However, alternative methods have also shown that similar results can be achieved with more direct and deliberate human interventions. A key debate in conservation has increasingly centred around the question posed here: which is the more effective way to preserve biodiversity – rewilding or direct management?

Biodiversity is the variety of plants and animals in an area. In order to increase biodiversity requires a variety of habitats that will attract different species. For example an area containing river, marsh, wood and meadow habitats will attract a diverse selection of species. Edge habitats often have the highest biodiversity.[2] For example the edge of a wood which is next to a meadow will have species that flourish in woodland, grassland, and those that require both trees and grass. For example the rare purple emperor butterfly chooses to live on the edge habitat of oak woodland.[3]

When we think about rewilding, the actions we decide on will depend on what we mean by 'natural state'. What counts as 'natural' is often a matter of opinion – and therefore partly political. For instance, the current 'nature' of the South Downs is entirely due to management through thousands of years of intensive grazing by non-

[1] Reardon, S. 2014, 'Return of the wild', *New Scientist* No.2958 p.40
Articles in the New Scientist are usually written by science journalists who will have a background in science but aren't necessarily practicing scientists. They are written in a journalist style, which may sometimes exaggerate ideas in order to create more memorable information.
[2] Ross, D. 2013 Community Ranger Lewes District Council, [interview 15th November 2013].
As the ranger of the Railway Land reserve Dan Ross does both hands on management and strategic decision making. This makes him an expert. He also has a vested interest in favour of management. The interview is a primary source and was tailored to find information that specifically helped my project.
[3] Burrell, C. 2013, landowner Knepp Castle Estate, [interview 13th November 2013].
Charles Burrell is a landowner and arable farmer and is internationally known for his rewilding project. He has 13 years experience of rewilding over 3000 acres. He is very knowledgeable of the theory and practice of rewilding and has a vested interest in the success of his project. See ref.2 for interview reliability.

native species. This is a process of 'deflected succession'.[4] Over the years, humans have stripped away many key features of natural landscapes like the Downs. This doesn't just include species, but also entire natural processes. In cases like this, an environment can simply be left on its own to undergo what might be called a mild form of 'rewilding'. But rewilding in the stronger sense of returning to an original 'natural state' would require major inputs to re-establish what has been taken away.

Dominant human interactions with the environment, like farming and forestry, seek to control nature as much as possible. Much conservation management is based on a similar philosophy. Emphasis is placed on controlling an ecosystem to deliver a particular 'tidy' idea of natural habitats. However what we view as 'destructive' or 'untidy' is often a misunderstanding of essential natural processes, many of which cannot be artificially matched.[5]

Deciding on the appropriate 'natural state' to rewild to requires careful analysis of the natural capacity that remains in a given area. We may not be able to re-create a certain ecosystem, if aspects of it no longer exist. These aspects can be as small as one particular type of animal or plant if it is a 'keystone species'.[6] These species have significant knock-on effects on webs of interdependencies, acting as 'ecological engineers' that shape and drive an entire ecosystem.[7] The same system cannot develop without them.

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[4] Whitbread, T. 2013, Chief executive of Sussex Wildlife Trust, [interview 20th November 2013]. Tony Whitbread has not only been chief executive of the Sussex Wildlife Trust since 2006 but was Head of Conservation from 1991. He has a PhD in Grassland Ecology, a BSc in Applied Biology and is also working for the Nature Conservancy Council and the Royal Society for Nature Conservation (RSNC). He has an interest in rewilding and writes about it in his blog. He has visited many rewilding projects including Oostvaardersdplassen nature reserve in the Netherlands. Locally, the Sussex Wildlife Trust is involved in the Knepp Castle rewilding project. See ref.2 for interview reliability.

[5] Whitbread 2013

[6] Vines, G. 2007. 'Don't fear the beaver', *New Scientist*, No.2618.
For reliability of New Scientist articles see ref.1

[7] Packham, C. 2012. *Secrets of our living planet,* 4 part series BBC.
Chris Packham has a BSc in zoology. He is a well-respected and experienced ecologist. However, the series has been created with the purpose of attracting large numbers of viewers. Therefore the examples shown in the programme are likely to be the most striking, in order to make the programme as popular as possible. This said, the BBC makes strong efforts to protect its reputation as a broadcaster, by consulting other experts and checking carefully for reliability.

This leads to an apparent dilemma. If rewilding involves human inputs, then what is it that distinguishes it from ordinary conservation management? To be systematic in this essay, a consistent understanding of 'rewilding' needs to be used. This focuses on what happens after initial inputs have been made, where rewilding enables an ecosystem to create its own natural links and processes. The crucial distinction with conventional conservation management lies not in the absence of inputs, but in the absence of control. In rewilding, there is no precisely desired outcome. Unpredictable natural processes are allowed to create unexpected results, which are constantly changing. When referring to management, on the other hand, conservation interventions aim at securing a particular predicted outcome to do with increasing or preserving biodiversity, which is then maintained at this desired stage.

The research review will look at complex interdependencies in an ecosystem and the importance of these in conservation management and rewilding, especially when species are introduced. A good understanding of evolutionary history in the UK is vital to both methods, yet our understanding is hampered by the classic theory of natural succession that the UK was covered in dense woodland, with few other habitats. An alternative model is explored, one that gives a very different picture of how natural ecosystem used to look in prehistoric Europe. This has major implications for rewilding projects that aim to replicate the processes that created those ancient ecosystems.

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Research Review

Importance of complex interdependencies

Symbiotic relationships are at the heart of the ecological interactions that enable our planet to remain inhabitable. An example of these relationships at the large scale is the role plants and animals play in maintaining equilibrium of carbon dioxide and oxygen (respectively) in the atmosphere, to their mutual advantage. But these interdependencies also take place at a smaller scale, with individual species often being totally reliant on one another to provide ecological niches. For example, the Brazil nut tree in the Amazon relies on the female orchid bee for pollination, and the agouti rodent to distribute its nut. In turn, the tree provides the sole food source for both these animals.[8] Indeed, science journalist, Bob Holmes, has describes how even seemingly lifeless processes are shaped by organisms, such as where tree roots stabilise river banks and so shape the course of rivers.[9] In fact, Holmes describes how organisms can even effect planetary processes, 'from climate and atmospheric chemistry to the shape of the landscape and even, maybe, plate tectonics'.[10] Thus entire ecosystems are built up from the millions of complex interactions between organisms and their physical environments, such as through: trophic chains; mineral cycles; energy flows; and behavioural patterns. In this way, the very smallest of creatures can contribute to shaping the planet as a whole. An understanding of the workings of these ecosystems is essential in any attempt to control or change them. When thinking about management, ad hoc interventions such as removing organisms that are perceived to be destructive could cause serious problems if ill understood relationships are disturbed and have negative effects on increasing biodiversity.

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[8] Packham, 2012.

[9] Monbiot, G. 2014, 'how wolves changed rivers', available at: http://sustainableman.org/how-wolves-change-rivers/ Sustainable Man [accessed February 2014]
George Monbiot has a BSc in Zoology. He is very knowledgeable on environmental issues and writes for the Guardian, a liberal newspaper. His work can sometimes take on a campaigning and one sided stance.

[10] Holmes, B. 2013. 'Lifeless Earth: What if everything died out tomorrow'. Available at: http://www.newscientist.com/article/mg21929360.800-lifeless-earth-what-if-everything-died-out-tomorrow.html#.Uqg6J_RdUrQ [accessed 15th October 2013].
For reliability of New Scientist articles see ref.1

Of course, it is not to say that human intervention necessarily reduces the complexity of a wild ecosystem. For example, the pearl-bordered fritillary butterfly is known as the “lumberjack’s friend”, because they move in to inhabit the clearings made by woodcutters.[11] Species that become reliant on human intervention may then benefit other species. In this case low grasses also attract grazers, which in turn help maintain the open space. But the point here is that the resulting eco-system can be seen as ‘unnatural’. This means that the changes may conflict with ecological relationships that have evolved over very long periods of time. In any case, it is also true that relationships created by human intervention are often temporary, as human behaviour is forever changing, which makes them unsustainable.

By rewilding an ecosystem we are allowing these relationships to form as naturally and undisturbed as possible. However this means rewilding projects also require good advance understanding of ecological relationships when thinking about the kinds of inputs required for rewilding. For example care must be taken only to re-introduce native species or proxy species (a modern relative of an extinct species) to create relationships that are as natural as possible. Provided that the area of land is sufficient and with the appropriate capacity, then intricate symbiotic relationships may (re)form. The result can be the (re)creation of unique natural landscapes.

The key point is that in any attempt to increase biodiversity, through either management or rewilding, we need to work with, rather than prevent these complex relationships. These webs of interdependencies are part of what allows an ecosystem to flourish and so play a fundamental role in raising the level of biodiversity in the UK.

[11] Blencowe, M. 2013, Sussex Wildlife Trust’s Community Wildlife Officer, [interview 13th November 2013].
Michael Blencowe is an experienced Sussex Wildlife Trust Community Wildlife Officer. His main focus and interest is in specific species, such as moths and butterflies which flourish on the South Downs. He has a vested interest in trying to preserve those species in intensively managed systems rather than risk their extinction if the land was allowed to be rewilded. See ref.2 for interview reliability.

Why we need to understand pre-historic ecosystems

The classic picture of current wild woodland in the UK is a gloomy habitat with low biodiversity. The wild woodlands we have today have relatively little variety of species since the habitat is fairly uniform throughout the wood and the ground cover is scarce since the trees block out the light.[12] This low biodiversity is because it has developed without the presence of past species and processes that would have enriched the whole ecology. What is meant by rewilding, therefore depends on close study of changing UK wildlife over time. And different points in time provide different refrence points for what rewilding is trying to re-build, and whether this will increase the biodiversity.

Both for rewilding as well as for management the capacity of an area of land needs to be carefully analysed and understood. This can be done by learning the natural histories of landscapes and understanding how structural features came to arise and what functions they perform. However, it may often be that key elements have been lost which cannot be returned. Not least, this may be because these crucial details may remain unknown. Therefore, re-building a landscape to increase biodiversity will always involve uncertainty. In the case of management, on the other hand, any unwanted developments that may arise, can always be eliminated to an extent. So, in management, uncertainty is less of an issue. This means that rewilding relies to a greater extent on sufficient knowledge to get the initial inputs right. This is why a good understanding of UK natural history is more relevant to rewilding than to management.

Frans Vera's theory of pre-historic Europe

The leading Dutch rewilding researcher, Frans Vera, has developed a theory that herbivores are the ecological engineers that drive an ecosystem. In his book 'Grazing Ecology and Forest History', Vera describes a detailed model of how natural ecosystems used to look in prehistoric Europe.[13] Instead of the generally

[12] Whitbread, 2013

[13] Vera, F. 2000. 'Grazing Ecology and Forest History'. Wallingford: CABI publishing p.6
Frans Vera is a Dutch biologist and conservationist. His theory has had a major influence on conservation but remains controversial. He is the visionary behind the rewilding project at

prevailing view that Europe prior to human agriculture was originally covered in thick woodland, Vera believes that there were large areas of parkland as well, which occurred totally naturally. His theory is that ever-changing patterns of parkland and woodland were sustained by native species alone, without human intervention. As brambles and shrubs start to grow, they are prevented for long periods from growing tall by herbivores like the auroch (an extinct large wild cattle) constantly eating the young plants. Eventually a bramble will grow to the point where it can defend itself with its thorns. This bramble then acts as protection for young trees growing up within. Oak trees in particular, thrive in open space rather than woodland. As these protected trees begin to grow up, the area of brambles and trees expands. As the emerging tree canopy overshadows the brambles, woodland is re-established. However, when this develops into closed canopy woodland, trees like the oak are outcompeted for space and so do not survive. When these oak and other trees die out, they create open space again, and so the cycle continues.

The fact that oak trees are still such a common species in the UK is thought to be evidence for Vera' theory. Since these die out in dense woodland, they would not have survived if the UK had been so entirely covered in closed canopy woodland as is often supposed.[14]

Exploring Frans Vera's theory

Interviews with Sussex Wildlife Trust conservationists helped significantly to enrich this picture. Chief Executive Tony Whitbread and conservation officer Michael Blencowe gave me valuable insights concerning the more detailed history of UK ecosystems and more local natural history (for full notes from these interviews see appendices 3 and 4). Whitbread emphasised the scale of these ancient natural landscapes.[15] He explained how processes of natural destruction like storms can have a much greater effect on large scale woodlands due to knock-on effects in which the density of tree cover intensifies the damage. The huge effect on woodland was demonstrated by the 1987 hurricane in the South East English when 15 million

Oostvaardersplassen, where he manages the reserve. He has first-hand knowledge and experience of rewilding but has been criticised for lack of scientific monitoring at the reserve.

[14] Burrell, 2013

[15] Whitbread 2013

trees were blown down.[16] Even though such events occur around once a century, their impact can be vital to the diversity of ecosystems.

In a separate interview, Michael Blencowe explained how it is not only a matter of geographical scale, but also the size of the trees themselves.[17] Most current UK woodland is not true wild woodland in the prehistoric sense. In real ancient woodland, huge veteran trees grow to such a size that they knock down other trees when they fall, creating larger clearings than would occur today.

Whitbread also pointed that critics of rewilding draw on the fact there are few large scale natural areas in the UK and therefore rewilding won't be able to create the variety of habitats required to increase biodiversity. Instead they believe that the most effective way to enhance diverse habitats in smaller areas is through management. This debate is explored further in the discussion.

How clues to the past can help increase biodiversity

In his 2013 book 'Feral' Guardian environment columnist George Monbiot also talks about how the UK used to look.[18] Monbiot describes how the UK during the Pleistocene period (1.6 million years ago to 11,000 years ago), was the home of a great variety of now-extinct large mammals called the Pleistocene megafauna. As climate cycled over this period between cold glacial eras and warmer interglacials, the kinds of ecosystem varied. It is only by thinking over these long periods, that we can realise how ecological change is both profound and routine. Management tries to restrict and deny ecological change. Rewilding goes with it.

Backing up his points Monbiot shows how some little-noticed features of current UK wildlife, provide fascinating clues to these past ecosystems. This evolutionary evidence includes particularly interesting examples like the abilities of many

[16] Metoffice education, 1987, 'The Great Storm of 1987'. Available at: http://www.metoffice.gov.uk/education/teens/case-studies/great-storm [Accessed December 2013] The fact given is undoubtedly an estimation but the Met Office is generally considered a reliable source.
[17] Blencowe 2013
[18] Monbiot, G. 2013, 'Feral', chapter 7 'Bringing Back the Wolf' London: Allen Lane
For background of Monbiot see ref.9. The information in 'Feral' is likely to have been selected to portray the positives of rewilding.

European tree species to regrow from the point at which the stem is broken. This characteristic could be explained by the habits of elephants and other Pleistocene megafauna of snapping or uprooting trees. In eastern and southern Africa, there are dozens of tree species which coppice from snapped trunks. Ecologists recognise this as an evolutionary response to elephants. As these plants continue to arm themselves against threats that no longer exist, Monbiot describes our ecosystems as “spectral relics of another age”.[19] That these features are still so prominent today, might perhaps be taken as evidence that some of these ancient inhabitants or proxy species could live in the UK again. Taken at face value, this evidence makes it seem possible that rewilding could bring back high biodiversity to the UK.

[19] Monbiot, ‘Feral’ p.93

Discussion

There is a big question over whether, and how well, the practical realities of rewilding could fit in with our current densely populated and intensively used landscape. Many of the processes that created the ancient patchwork of parkland and woodland that are so important to biodiversity require large areas of land. There are few areas of countryside in the UK that are large enough to see these processes take sufficient effect. This is a major strand in the argument that the most practical way to build high biodiversity in a country like the UK, is not rewilding, but more conventional forms of conservation management.

Rewilding may be more risky than management since we don't know what the outcomes will be and whether they will in fact increase biodiversity. But inevitable unexpected outcomes can be enormously positive. With so few natural areas left, maybe we need to be giving Nature as much freedom as possible?

Reliability of Conservation Management

Conservation management offers many benefits in the complex and demanding circumstances of the modern UK countryside. Intensive human intervention and destruction over thousands of years have changed habitats to the point where many species are now on the edge of extinction. And this is in addition, of course, to the thousands of species that have already been made extinct. Many habitats in Britain are entirely lost to conservation through intense urbanisation. And these dense urban populations further erode habitats elsewhere, by requiring enormous diversions of natural resources – like food production and river water for drinking and industry. It is for these reasons that the argument is often made that the most reliable way to return rich habitats that hold high biodiversity is not through rewilding, but more active forms of conservation management. Tony Whitbread describes the arguments over these issues in brief claiming that 'Rewilders say this is a bad thing because conservationists ignore natural processes' and that 'Conservationists say

this is a good thing because current nature is the product of thousands of years of interaction between people and wildlife so we need to continue that interaction.'[20]

Active management is more reliable, because rewilding allows control only through initial inputs. Because active management addresses uncertainty through constant intervention, it can be much more confident about achieving a very specific rare habitat. An example is the Lewes Railway Land, which I visited during an interview with the ranger Dan Ross.[21] During this conversation and an earlier public meeting addressed by Dan Ross, Michael Blencowe and Railway Land founder John Parry, it became clear that the very particular reed bed habitat could only be maintained by intensive management.[22] A reed bed is an edge habitat of the kind discussed earlier as being especially beneficial in terms of biodiversity. In the Lewes Railway Land, the reed bed is the edge habitat of a small lake. It attracts many birds such as coots, water rail, pied wagtail and the reed warbler and reed bunting, which (as suggested by their names) are exclusive to reed bed habitats. Fish also flourish in the reed edge habitat. These include perch, rudd, European eel and 3-spined stickleback. Michael Blencowe described the reed bed as a 'declining habitat' in the UK at large. According to Dan Ross, it needs constant management: removing brambles which block out the light to flowering plants that provide nectar for insects; and the felling of trees such as willow, the roots of which would dry up the reed bed as it establishes.[23] This is just one example of the kind of management that Ross said was essential to maintaining the high biodiversity value of the Lewes Railway Land.

[20] Whitbread, T. 2014, 'Holes in the rewilding versus conservation debate'. Available at: http://www.sussexwildlifetrust.org.uk/blog/2014/01/holes-in-the-rewilding-versus-conservation-debate/ [accessed February 2014]
For background on Whitbread see ref.4
[21] Lewes Railway Land, East Sussex, Nature reserve since 1995, 25 acres, managed by Lewes District Council and the Railway Land Wildlife Trust, [visited 15th November 2013].
[22] Dan Ross (Community Ranger Lewes District Council), John Parry (Trustee at Lewes Railway Land Trust) and Michael Blencowe (Sussex Wildlife Trust's Community Wildlife Officer), Lewes Railway Land Linklater Pavilion, talk on progress of wildlife in Railway Land, [attended 27th October 2013]. The talk was aimed at encouraging public involvement. Information was bias to demonstrate the success of management.
[23] Ross, 2013

Dependence on human intervention

The BBC4 TV series 'Unnatural Histories' explains the important impact human intervention has on the famous Yellow Stone Park in Wyoming.[24] When they first established it as a nature reserve they drove out all the Native Americans that were living there. Soon the ecology changed drastically and it was found that the ecological engineer had been the Native Americans. Their lifestyle and relationship with nature had created the unique ecosystem at Yellow Stone.

Michael Blencowe explained how locally the intensively managed South Downs has an abnormally high biodiversity. The non-native sheep graze the hills evenly creating land which is said to have 40 species per square metre.[25] This is partly because chalk grass land has low levels of nutrients as a result of the water draining away so no species can become too dominant. The wide variety of grasses thrive in the absence of trees and undergrowth.

It could be viewed that in examples such as these, humans are as much a part of nature as the rest of the ecosystem. In fact, they may be the keystone species of particular ecosystems, as discovered in Yellowstone Park. Although human dependent ecosystems may seem unnatural it may also be that they can hold an unnaturally high biodiversity. Therefore the idea is that through management we can almost condense nature into smaller spaces that fit in with our growing society.

Are there benefits to extinction?

It is argued that there can in fact be ecological merits to mass death, such as the destructive method of trawling. While the seabed is stripped of life by the trawling nets, opportunity is created for other species. Such as softer, smaller worms which flourish with the removal of rivals. These worms then attract fish which feed on them,

[24] BBC4, 2013, 'Unnatural Histories*',* episode 2 of 3. Available at: http://www.bbc.co.uk/programmes/b011wzrc
For reliability of BBC see ref.7.
[25] Blencowe, 2013.

and so creating a new ecosystem.[26] While this shows the survival power of nature to re-fill empty niches it also raises another argument that perhaps nature can work with human meddling by rebuilding or recreating habitats.

Looking at destruction on the large scale, it is widely commented that the Earth may be undergoing a sixth great extinction caused by climate change and other human activities that is comparable to the asteroid strike that killed off the dinosaurs 65 million years ago.[27] This raises important questions about the 'naturalness' of extinction – even mass extinction. University of York ecologist Chris Thomas points out that 'all past extinctions were followed by a burst of evolution'.[28] For instance, the disappearance of the dinosaurs created space for mammals to evolve. Could it be that despite bringing on mass extinction, we are in fact creating an opportunity for a new evolutionary explosion?

Of course, this would be of little consolation to those alive during the period of mass extinction. But the real point here concerns the creative force of Nature. Active conservation management is based on the idea that humans must assume control. Rewilding strategies rely instead on the adaptive capabilities of ecosystems to heal themselves which often involves processes about which humans are ignorant. Past experiences of mass extinction provide further evidence for the power of these unknown dynamics. The wildlife broadcaster, Chris Packham, highlights in 'Secrets of our Living Planet' how much is still left to be discovered about the ways in which

[26] Pearce, F. 2013. 'Are there ecological merits to trawling the seabed?'. Available at: http://www.newscientist.com/article/dn24148-are-there-ecological-merits-to-trawling-the-seabed.html [accessed 23rd September 2013]
For reliability of New Scientist articles see ref.1

[27] Ananthaswamy, A. 2004, 'Earth faces sixth mass extinction'. Available at: http://www.newscientist.com/article/dn4797-earth-faces-sixth-mass-extinction.html#.Uw4asPl_sbg [accessed December 2013]
For reliability of New Scientist articles see ref.1

[28] Pearce, F. 2014, 'Evolutionary explosion', p.20. Available at: http://www.newscientist.com/article/mg22129510.400-human-meddling-will-spur-the-evolution-of-new-species.html#.Uw4c6_l_sbg [accessed January 2014].
For reliability of New Scientist articles see ref.1

ecosystems work.[29] It is perhaps through more open processes of rewilding that more can be learned about the complexities of ecology.

Rewilding success at Oostvaardersplassen

In Oostvaardersplassen in the Netherlands, over 6000 hectares of reclaimed land didn't dry out properly. So the government decided to make it into a nature reserve. The visionary behind the reserve was Frans Vera, who saw the opportunity to test his theory by trying to re-create the landscape of Europe's prehistoric past. Vera populated the reserve with proxy species related to those that lived thousands of years ago including horses, cattle and red deer. The distinctive feature of the Oostvaardersplassen project is that it was left to be totally 'untidy' for the first few years after the initial animal inputs. The reserve wasn't open to the public. Animals were left to their own devices to the extent even carcasses of cattle or horses were left uncleared.

Unexpectedly, the reserve soon became an ideal spot for greylag geese to malt.[30] During this season their grazing kept back shrub growth. Another emergent development was the appearance in the park of the white-tailed eagle and Eurasian black vulture, long absent from the area. In the future, Vera would like to introduce the bison, wild boar and wolf.

Critics and supporters of Vera's work at Oostvaardersplassen has been reviewed in a *Nature* article.[31] US ecologist, Dustin Rubenstein, said that 'placing proxy animals in a modern landscape … could spell trouble'. He suggests that proxy species 'could become invasive pests' resulting in 'trouble with landowners'.[32] On the other hand, another US ecologist, Stuart Pimm argued '[t]hey've got it right and a lot of things

[29] Packham, 2012.

[30] Vera, 2000. P.XV

[31] Marris, E. 2009, 'Conservation biology: Reflecting the past'. Available at: http://www.nature.com/news/2009/091104/full/462030a.html *Nature* 462 [accessed February 2014] Emma Marris is a science journalist on the staff of Nature, one of the most respected international journals of science. This piece is not a scientific paper but will have been well research to keep up Nature's reputation.

[32] Ibid

have come back as a consequence'.[33] This scope for disagreement arises because of the uncertainty involved with rewilding.

Political constraints on rewilding

In the UK Charles Burrell explained how his rewilding project at the Knepp Estate is constrained by UK regulations and animal welfare guidance.[34] This project currently covers an area of 3000 acres of previously intensive arable and dairy production. The land has been left to naturally regenerate and roe and red deer, Dartmoor ponies, Tamworth pigs and Longhorn cattle roam as freely as possible.[35] Like at Oostvaardersplassen, Burrell has introduced these grazer species as proxies for those that would have been naturally around in prehistoric Britain. Although wild boars do live in the UK, the Department for Environment, Food and Rural Affairs (Defra) imposes strict rules under the Dangerous Wild Animals Act as to how these can be kept.[36] So, to reduce human intervention, Knepp Estate uses Tamworth pigs as a substitute for wild boar. Another example of regulatory constraints is that neither Defra nor the RSPCA allow Burrell's herd of Long Horn cattle to breed naturally, since it is considered cruel to allow the young heifers to be covered by the bull in their first year. Therefore the heifers have to be removed and re-introduced at a later date, which disrupts the natural social dynamics of the herd.

Public pressure also has an influence on conservation management in public spaces. Dan Ross explained how management of the Lewes Railway Land nature reserve requires high priority be given to the wishes of the public. To be popular the reserve must be appealing and tidy. This means that fallen and rotting branches need to be cleared because they give a feeling of dying nature rather than increased

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[33] Ibid

[34] Knepp Estate, West Sussex, 3,500 acres, owned by the Burrells for over 220 years, arable and dairy farming until 2001, [visited 13th November 2013]

[35] Greenaway, T. 2011, 'Knepp Wildland project year 10 for the re-wilding project', *Knepp Castle Estate*
This report is adapted and updated from the Knepp Castle Estate 'Baseline Ecological Survey' by Theresa Greenaway (2006) English Nature. It is a published by Knepp Castle Estate so while it may be scientifically correct, it is bias to promoting the project.

[36] Defra, 2008. 'Feral wild boar in England: An action plan.' P.6. Available at: http://www.naturalengland.org.uk/Images/feralwildboar_tcm6-4508.pdf *Natural England* [accessed November 2013]
This is a government department briefing paper, so reliably details the laws on wild boar.

biodiversity. Yet the natural processes of rotting trees and branches act as a perfect habitat for many insects. Similarly, George Monbiot describes in 'Feral' how the upturning of soil by wild boar is often viewed as destructive to a landscape.[37] At Knepp Estate I saw similar behaviour by Tamworth pigs, which not only naturally ploughs and fertilises the soil, but also attracts birds by unearthing insects. The dug up areas can also become little ponds and miniature wetlands. This behaviour creates 'a shifting mosaic of tiny ecological niches' which are so important to increasing biodiversity.[38] There are many examples like these, where what appears to be destructive and untidy may be a beneficial ecological change. This need for 'tidiness' makes rewilding harder to do in nature reserves that require public support, like the Lewes Railway Land.

Unexpected outcomes at Knepp Estate

Despite the UK regulations, Burrell informed me that Knepp Estate has already shown impressive unexpected outcomes. For example work by ecologist Olivia Hicks in 2012 showed Knepp to be home to roughly 1% of the UK's nightingale population.[39] In 2013, ecologist Isobel Donovan found that this population had increased by 100% in just one year.[40] Since rewilding, Burrell also claims Knepp Estate holds the UK's second largest population of the rare and elusive purple emperor butterfly.[41] Leaving species to their own devices has also resulted in interesting behavioural outcomes. The Tamworth pigs have developed an unexpected foraging habit: going into the lake, using their snouts as snorkels and digging up swan mussels from the mud, which they then prise open using their teeth

[37] Monbiot 'Feral' p.95
[38] Ibid.
[39] Hicks, O. 2012, 'The impacts on bird diversity of re-wilding an intensive farm – a focus on the nightingale Luscinia megarhynchos' MSc thesis (unpublished)
This is MSc student thesis, the facts would have been well researched but there is no peer review.
[40] Donovan, I. 2013, 'Wild Thing: the effect of re-wilding on the densities of a group of Bird of Conservation Concern species.' MSc thesis. (unpublished)
This is MSc student thesis, the facts would have been well researched but there is no peer review.
[41] Hulme, N. & Oates, M. 2013, 'Preliminary Report on Purple Emperor Butterfly Surveys, Knepp Castle Estate' (unpublished)
It is a preliminary internal survey, it is not peer reviewed but is the only information available. Further studies are required to confirm the information.

and trotter.[42] The knock-on effect of these natural behaviours will likely create further unpredictable outcomes. It is relationships like these that are lost in management.

At Knepp Estate I saw oak saplings growing up in what was previously an arable field in the shelter of brambles, protected from the grazers, just as Vera describes (see appendix 1 for photo). On a walk in Ashcombe wood, Lewes, the same process was clear but at a later stage (see appendix 2 for photo). The proponents of rewilding argue that nature can establish diverse habitats on its own and therefore increase biodiversity.

Re-introduction of species

As rewilding involves re-introducing native species or proxy species re-introduction is often needed to re-establish species that are no longer present in the UK as a whole. Chris Packham's television series shows how important each species is to an ecosystem. This can be an argument both for and against re-introduction.

Political sensitivities to re-introduction

A difficulty is the need to understand in advance the ecological relationships of a re-introduced species. The potential ecological change one species can bring could threaten to push out other fundamental species. Re-introduction can also become very political, where strong insider pressure groups like the National Farmers Union (NFU) in the UK can have huge impacts on re-introduction policy. The NFU influences Government policy prioritising livestock and agricultural over wildlife. This links to the concern of Dustin Rubenstein about Oostvaardersplassen possibly interfering with local agriculture. The risks posed by new species can take many forms. Disease is a particular factor when considering re-introduction. The sensitivities are well illustrated by the controversy over the present UK badger cull, where badgers were killed for spreading bovine tuberculosis to domesticated cattle.[43]

[42] Burrell, 2013.

[43] Highfield, R. 2007. 'badger cull could 'double fox populations'". Available at: http://www.telegraph.co.uk/science/science-news/3319374/Badger-cull-could-double-fox-population.html [accessed 24th October 2013].
The Telegraph is a conservative newspaper and so would have a vested interest supporting those who are strongly conservative, namely members of the NFU. However this article talks negatively of the cull by talking about how fox populations will grow. This perhaps makes the article more reliable.

The badger is still present as a native British species, so this shows just how sensitive entirely new re-introductions might be. Other political sensitivities can arise in emergent ecological outcomes. An example of this is given in 'Unnatural Histories', where insufficient knowledge of the natural ecology caused problems in Yellowstone Park. In order to protect elks, all the wolves were culled. At first, the impact wasn't apparent. But after a while elk numbers rose and the park became overgrazed. This showed the essential role of wolves in the ecosystem. A wolf re-introduction programme began in the 1990s.

Positive ecological effects of the beaver

More favourable effects can also arise from species re-introduction. For instance, the beaver was once native to the UK and is being considered for re-introduction. In a recent New Scientist article Gail Vines describes the beaver as a 'keystone species' whose 'presence benefits dozens of others'.[44] Vines also describes them as 'the quintessential ecosystem engineers' because they single-handedly create an ecosystem with 'habitats suitable for up to 32 species in need of urgent conservation action'. Although not without the political and economic issues discussed earlier, the beaver does seems to bring more than ecological merits. For example Vines describes how agricultural discharges of eroded soil and fertilisers dropped by 90% in beaver-dammed streams in Brittany. Another example she gives of the beaver doing ecological tasks for free, is the coppicing of willows along river banks which would normally cost up to £11,000 per hectare. It is this quality of encouraging many different niches, allowing biodiversity to flourish, that can lead to the most effective kinds of rewilding.

Re-introduction of predators

Even more controversial questions surround the possible re-introduction to the UK of some of the largest formerly native predators, such as the brown bear, lynx and wolf. Tony Whitbread explained in the interview that predators don't only cut down herbivore numbers by eating them, but they introduce a fear factor which totally

[44] Vines 'Don't fear the beaver'
For reliability of New Scientist articles see ref.1

changes the behaviour of their prey. The short video 'How Wolves Change Rivers' by George Monbiot talks again about Yellow Stone Park and particularly about the ecological effect of the wolves as a predator.[45] Monbiot explains how re-introducing wolves to Yellow Stone allowed vegetation recovering from grazing to strengthen riverbanks and so change the course of rivers.

UK grazers currently live without fear of predators hiding behind each bush. This leads to landscapes like the South Downs, where grass is grazed evenly and intensively right to the edges of scrub. If threatening carnivores were present, the land would be grazed unevenly depending on how exposed an area is. This simple behavioural change forms entirely different ecologies, allowing a more diverse range of species to inhabit different niches and a consequent increase in biodiversity. Given the influence of the NFU, the most likely re-introduction of a UK predator would be the Lynx, which wouldn't endanger livestock as a carnivore. In another New Scientist article Gail Vines comments that 'if lynx died out through hunting rather than climate change, there's good reason to bring them back'. [46]

Rewilding and re-introduction

In rewilding, the initial inputs to a landscape should be based on knowledge of the history and whether the area has the capacity to once again host these inputs. For reintroduced species, this can be difficult to know. It seems that in order to be as effective as possible in rewilding, key-stone species need to be re-introduced. However there are many issues around re-establishing a species in the UK. By raising the chances that re-introductions will be rejected, these political complexities reduce the options for UK re-introductions, meaning that rewilding programmes may not be as effective as they could be.

[45] Monbiot, 2014, 'how wolves changed rivers'.
[46] Vines, G. 2007,'The bone-man's legacy', *New Scientist.*
For reliability of New Scientist articles see ref.1

Conclusion

It seems that conservation management is reliable, can create unique high biodiversity habitats and fits in with our society in the UK. On the other hand management often restricts ecological change and prevents natural relationships and processes which are vital to increasing biodiversity. Rewilding requires careful decisions about the initial inputs but then can be left to develop, allowing these relationships and processes to form naturally with unpredictable but potentially hugely beneficial outcomes for biodiversity. The risks and 'untidy' nature of rewilding make it unpopular with farmers and the public. Introduction of 'key stone' species, which are so essential to successful rewilding, is thwarted by regulation and industry interests.

Despite all these practical arguments there is a big question over whether we should interfere with any aspects of nature in the way conservation management does. It could be seen that trying to control nature is an "oxymoron".[47] Critics claim that rewilding neglects nature, since so much of nature has been stripped away already. Some aspects of nature now can't survive without human intervention.

Knowledge and understanding of evolutionary history, complex interactions and webs of interdependencies is essential to both methods. We are only beginning to understand how these operate. With rewilding, making the right choices about inputs determines how the ecosystem will develop and support itself. With management complex interactions and processes need to be understood in order to preserve and enhance the biodiversity.

For all its difficulties rewilding offers inspiration and a sense of excitement for the future of conservation. Oostvaardersplassen now has a visitors centre that attracts

[47] Whitbread, T. May 2013, 'Putting the "Wild" into "Wildlife"'. Available at: http://www.sussexwildlifetrust.org.uk/blog/2013/05/putting-the-wild-into-wildlife/ [accessed October 2013]

200,000 visitors a year.[48] Knepp Estate is investing in safari visits and holidays. The future of rewilding depends partly on public enthusiasm and support to gain acceptance for further large projects.

On the UKs smaller reserves where management has been a success in enhancing biodiversity a compromise could also be made. Looking at the advantages of management and of rewilding could potentially lead to use of both methods to create the highest biodiversity.

[48] Staatsbosbeheer. 'Oostvaardersplassen/facts and figure. Available at: http://www.staatsbosbeheer.nl/English/Oostvaardersplassen/Facts%20and%20figures.aspx [accessed March 2014]
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Appendices

Appendix 1

Oak sapling growing up through a thorn patch established in what was only seven years before an arable field. The circle shows part of the oak sapling growing up between brambles, with its distinct oak leaves.

Appendix 2

Photo I took of an oak tree in Ashcombe wood, Lewes. As you can see surrounding the base of the trunk are a cluster of brambles from which the sapling of this oak probably used as protection in order to grow into the huge tree that you see.

Appendix 3

Notes from interview with Tony Whitbread:

He finds the concept of re-wild fascinating. While he loves the idea he expressed many angles on it. Like Charlie Burrell at Knepp estate Tony said that it isn't re-wilding if you just leave an area to grow. This is because we have taken so much away over thousands of years. Tony also added that we have not only taken away physical things like animals and plants, but we have also taken away natural processes. Many that we may not know even exist. For example natural disturbance. To re-wild we have to put processes back - this includes certain species.

He really liked my idea of classing re-wilding as unexpected/unpredictable outcomes. In my project I could talk for ages about what re-wilding actually is, but this is quite off topic so to save this I will discuss how there is no specific definition and I will tell them what I am talking about when referring to re-wilding. Tony said that if you re-build ecosystems and then leave them you get emergent properties - key word - which are unexpected properties. He gave the example of somewhere called Oostvardersplassen in Holland where over 6000 hectares didn't dry properly and so they made it into a nature reserve. It then became the ideal spot for the Grey Lag geese to come and malt. This changed the whole ecology because they grazed the land.

We talked about how humans like to think they are in control of everything - sometimes this can be imaginary control. Often natural process are more efficient than artificial versions, but it all seems less tidy. All the big farming businesses think of profit and link this with creating a high yield, however me and Tony were discussing how it may be a higher profit to put less in and get less out. So leaving the process to nature means no artificial interference which is expensive. And without this level of control there will be a lower yield, but the profit gained may be significantly more.

We also talked about predators. He told me something really interesting which was that they hardly affect the numbers of their prey but their main influence is effecting the behaviour of the prey. In the UK we should naturally have wolf, lynx and bear - Tony thinks that of the 3 lynx is the most likely to be re-introduces, because they don't threaten people or livestock. The way predators effect the behaviours is that they keep them moving, so you get certain patches that are more grazed that others because certain areas are more safe for the prey. This creates different ecologies with different rates of grazing.

In comparison the South Downs which I have found out a lot about from Michael are grazed by sheep. Sheep are not native to the UK and also they have no predators so they comfortably graze the land evenly. Before sheep there were aurochs - which

were huge wild cows. These went extinct in Europe in 1627. These would have done similar grazing to the sheep, but they were aggressive and a threat to humans so we switched. Sometimes really interesting is that the South Downs at the moment only have 2% of permanent chalk grassland - the rest is agriculture. However if it was natural Tony said that 20 or 30% would be grassland in natural woodland. He says this would be caused by storms, diseases, aurochs - not only grazing but knocking down trees and pathways - and also beavers create dams that then cause a flood to the surrounding area drowning trees and creating open space. He also agreed with Michael's point about ancient trees dying and creating spaces. He says evidence for this is the fact we have open trees that only survive in open spaces, Such as oak, have always been around.

I asked him about the ethical side of management and re-wilding and what he thinks is morally right. He said that it depends how you view it. by re-wilding it could be seen that we are neglecting nature and we have already stripped away so much and now it depends on management. Or you could look at it that trying to control nature is wrong. I think that the most important factor behind re-wilding and management is understanding nature whatever action we decide to take.

Tony said that he views the temporary situation as trying to retain fragments. The fact we have these small fragments rather than big areas creates another huge issue when looking at thinking about re-wilding. A way we have lost the natural process of natural disturbance if by not having these big areas. In a large scale natural environment gap-phase dynamics (storms making gaps) have a huge impact and although they aren't often they change the ecology in a huge way when they do occur - create open spaces. However not having big areas has meant that storms don't have as big of an impact of the area as a whole and they don't happen often enough to effect the ecology in such a major way. Therefore for the situation we are in we need management to mimic what nature would do.

Appendix 4

Notes from interview with Michael Blencowe:

He works with moths and butterflies and so he sees the high biodiversity in the chalk down land of the South Downs as a fantastic thing. He said that there are 40 species per metre squared. He said that because chalk grass land has low nutrient as a result of the water draining away nothing dominates. The land is intensively grazed which also stops dominant species such a bramble from growing up and outcompeting the low ground species. Michael said that lots of competition means a high biodiversity. As a result of lots of flowers and grassland there’s lots of nectar and plants as food for insects like caterpillars. Michael described it as an English

"rainforest" in terms of biodiversity. The Downs are totally dependent on management, otherwise they the biodiversity that is there would be drowned from light. He gave many examples about Heathlands in West Sussex that the Sussex Wildlife Trust are involved with.

Something that was particularly interesting was what he said directly against re-wilding rather than arguing that management is a better alternative. He said if you have an area of land like the downs, and you leave it with no intervention - meaning no intensive grazing from sheep - for around 20-30 years it will have turned into a pretty established woodland, that would turn into a closed canopy woodland. This would have a low biodiversity as the only species that would benefit would be the dominating trees and animals like wood pigeons. I asked him why it was that the natural woodland was so bad for biodiversity. He said that a lot of the species that suffer in woodlands have developed with thousands of years with humans. For example the butterfly Pearl-bordered Fritillary is known as a lumberjacks friends because it would always inhabit the spaces the lumberjacks would clear. I asked what these did before human forestry was on such large scale. He said that in the UK we should have ancient woodland, that has huge ancient trees, which clear big spaces when they fall and take down other trees. Now we have very few ancient woodlands, and so the woodlands we have would need to develop for thousands of years before they can be inhabitable for the biodiversity that lives on the downs now. So he argues we have destroyed all the true climax communities and so to start re-wilding now will only end in a huge reduction of biodiversity - many species are now dependent on human intervention for survival.

Is the most effective way to increase biodiversity in the UK though conservation management or rewilding?