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BIODIVERSITY OFFSETTING – WHAT DOES THE SCIENCE SAY?

Summary report from a meeting of the British Ecological Society

Biodiversity offsetting has been heralded as a tool to balance economic growth and environmental protection. By identifying and quantifying the environmental impact of development on biodiversity, offsetting could help bring the cost of impacting nature into projects where it is currently left out. The British Ecological Society believes that it is essential that offsetting policy is evidence-based and that offset systems are grounded in the best ecological science. The BES notes the limited reference to science in the Green Paper and considers this to be an important omission.

Summary

1. Any biodiversity offsetting policy implemented in England must be evidence-based. Offsetting decisions and protocols are underpinned by both scientific and value judgements, and for ecological science to be used effectively, Defra must distinguish between these and treat them accordingly.

2. Ecological science is integral to the development and implementation of an offsetting policy in England. Offsets must be both designed based on best available scientific knowledge, and monitored effectively to ensure performance is objectively assessed and any offsetting approach is therefore improved where necessary. We highlight several areas where the contribution of ecological science is particularly key to the development of an effective offsetting policy.

3. Current ecological knowledge that is applicable to offsetting needs to be organised in an open manner using consistent and compatible approaches, at an appropriate scale to reflect local and national values. This paper begins to identify areas where this might be possible, but further work is needed to map current and potential habitat and to confirm reliable indicators of habitat condition.

4. If an offset scheme is implemented, there will be a need to both review practical experiences and to carry out further ecological research to ensure that environmental outcomes will be resilient given future changes in environmental conditions and the development landscape.

5. Offsetting policies need to provide clear definitions of metrics and exchange rules to allow projects to be objectively assessed and compared, and therefore improved where necessary. Defra should seek advice from ecologists in developing a framework for specifying appropriate baselines and a robust definition for 'no net loss' at local and national scales.

6. Ecological science plays a key role in the appropriate implementation of offsets as part of the mitigation hierarchy. The use of the mitigation hierarchy is critical in helping to ensure that unnecessary impacts of development on the environment are avoided. Ecological science can help with this process, helping to establish which impacts might be impossible to offset and whether proposed offsets are technically feasible.

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Introduction

1. In anticipation of the development of biodiversity offsetting policy in England, The British Ecological Society held a meeting on 17 September 2013 to draw together expertise on the science behind offsetting. Researchers, ecology practitioners and others assessed the role of ecological science in the offsetting debate, and how it might contribute to ensuring that further developments are evidence-based, and as ecologically robust as possible.

2. The purpose of this document is to give some indication of current ecological research Defra should be aware of when developing plans for offsetting in England, and to note where ecological science could potentially contribute through further research. In that sense we are describing both 'what the science currently says' and 'what science could tell you'. We emphasise the nascent nature of the science and practice of biodiversity offsets, both in the UK and globally.

3. Although it should be underpinned by science, biodiversity offsetting also requires a number of value judgements. Such value judgements can be hard to balance and reconcile in a way that is defensible to all stakeholders. As an example, a value judgement is made when deciding to allow the exchange of losses in agricultural land for gains in a different habitat of higher conservation value. Having made that judgement, science can then give a structured and defensible equivalence scale to inform choices made. By focusing on the scientific side of offsetting – namely ecological research, a rigorous evidence-based approach to offsetting can be developed.

4. In addition to assessing trade-offs, there are other areas where value judgements are important in offsetting schemes:

    - Financial instruments for funding offset projects;
    - Legal instruments for offsetting, such as easements or covenants;
    - Delegation of responsibility for management and monitoring of offsets;

    Some aspects of biodiversity offsetting, such as the appropriate location of offsets, will require both scientific and value judgements. Distinguishing between these is key to ensuring ecological evidence can feed in to decision making.

5. The BES has chosen to focus on ecological science because this is the area that corresponds to the expertise of its members, and because there is a limited focus on science in the Green Paper. Many other organisations will be commenting on the other areas above and their contributions will need to be considered carefully alongside the science. It is important, however, that value-based judgements are not used to dilute the integrity of the concept of no net loss of biodiversity.

Offsetting and evidence

6. Any biodiversity offsetting policy implemented in England must be evidence-based. This means both making use of the best available scientific knowledge and ensuring the performance of the policy can be objectively assessed through a detailed public record of any offset schemes. Ecological science has an integral role to play in both of these elements and can contribute to the planning, implementation and monitoring stages of an offsetting policy.

7. The implementation record of offsetting and similar approaches in the peer-reviewed literature is mixed (see recent reviews by Bull *et al*. 2013; Gardner *et al*. 2013). There are a number of practical and theoretical challenges to offsetting, which can make the delivery of schemes difficult.

The outcome of a project can be highly dependent on practical implementation of techniques and success criteria used. A lack of clarification from documentation surrounding offsetting can often lead to different projects using different baselines and accounting frameworks, weakening confidence in conservation outcomes. There are also many technical challenges which can hamper the success of offsets in practice. Some of those referred to in recent literature include:

- Partial definitions of no net loss which omit key biodiversity components or fail to address essential processes needed to support successful outcomes in the longer term;
- The challenge and complexity of interpreting outcomes in terms of no net loss or ecological equivalence, even when these target only one species (Pickett *et al*. 2013);
- The challenge of obtaining sufficient data to understand dynamic baselines (Traill *et al*. 2007; Pickett *et al*. 2013);
- The fact that ecological damage is frequently immediate and certain whereas compensation via restoration will appear with a time delay and is uncertain (Harris *et al.* 2006; Zafra-Calvo *et al*. 2010).

8. This does not necessarily mean that offsets cannot work in practice, or that there is not potential for environmental benefits from an offsetting approach. The use of offsets does, however, need to be appropriate. Adhering to the mitigation hierarchy of ‘avoid, mitigate, compensate’ in the first instance is critical in helping to ensure that unnecessary impacts of development on the environment are avoided and limit offsetting only to residual impacts.

9. Demonstrating that biodiversity offsetting will be an effective mechanism to compensate for habitat loss or degradation due to unavoidable impacts will rely on knowledge about the restorability of different habitats in different contexts. Restoration of ecosystems that have been degraded, damaged, or destroyed is not a new concept in ecology. Interest in ecological restoration has been developing over the last four decades, and has a strong grounding in ecological science (Jordan *et al*. 1987). Restoration ecology is a thriving area of research, which has received increased focus over the past few decades. In the Journal of Applied Ecology, articles that focus on restoration ecology have increased from 0 in the early 1980s to 12% of papers published annually in 2003 (Ormerod 2003) and this trend has continued into recent years. Much of this research has been focused on habitats in England which will be affected by development and for which offsets may be required, including woodlands, grasslands, heathlands and peatlands.

10. Ecological research has been key in developing biodiversity offset policies around the world, including Australia, South Africa and Madagascar. This is particularly true in Australia, where the government’s EPBC environmental offsets policy is shaped and informed by robust and relevant science, and where scientific certainty is lacking the precautionary principle is adopted (Australian Government, 2012). There is therefore potential for ecological science to input into offsetting discussions to form a robust and science-led policy in England. The need for greater use of ecological science in offsetting policy was highlighted by Maron *et al*. (2012). After assessing the effectiveness of restoration in biodiversity offsets, they concluded that ‘*many of the expectations set by current offset policy for ecological restoration remain unsupported by evidence*.’ We identify several areas where the contribution of ecological science is particularly key to an offsetting policy:

- **Estimating habitat restorability**;
  Both the study and implementation of restoration ecology can contribute to understanding how successful offsetting projects will be in practice. In England, there have been a number of projects carried out to restore degraded habitats, including restoration of

peatland, woodland and areas of the Fens. The success of these initiatives needs to be followed up to inform and develop any future restoration projects. A recent assessment of salt marshes in England showed that artificially created salt marshes suffered significantly reduced biodiversity compared to both natural salt marsh areas and sites created accidentally by storm surges, highlighting the difficulties of restoration in practice (Mossman *et al*. 2012).

- **Understanding uncertainty and risks***;*
Ecological restoration can be a slow process and have uncertain outcomes. If used to deliver offsets, the inherent uncertainty of restoration outcomes needs to be taken into account. This could be minimised through the development of a framework assessing the uncertainties that could arise for restoration offsets in different habitat types and considering scope to address them. The work done by Pilgrim *et al*. (2013) to identify situations where offsets are likely to be particularly hard to deliver gives an example of how science can help offset practitioners on these difficult issues.

- **Achieving no net loss;**
Ecological science is needed to underpin workable definitions of no net loss as required for any offsetting project and to ensure that conditions are clearly established. A comprehensive understanding of biodiversity is required to achieve no net loss in any offsetting policy. Gardner *et al*. (2013) explore in detail what no net loss means for biodiversity. Scientific underpinning is also important for robust implementation and monitoring. Without clear no net loss objectives to guide offset design and implementation, the successes of offset schemes are hard to review. Use of current ecological datasets and strategic frameworks can support definitions of no net loss which allow explicit trade-offs to be made through offsetting at both local and national scales.

- **Providing data and information on distributions of habitats and species populations;**
Large amounts of ecological data relating to habitat characteristics, regional conservation significance and ecological functioning are available in England. Research institutions, researchers and non-departmental public bodies have collated information across many of England's habitats. There is therefore much potential for offsetting policies to make use of this data and knowledge in order to make evidence based decisions.

- **Classification and condition assessments of habitats and their function within ecosystems.**
Much ecological science has dealt with understanding habitats in the context of wider ecosystems and the contribution they make to ecosystem function and services. Use of such information, for example the role of keystone species, can therefore allow the impact of offsets to be greater understood and considered at a wider landscape level.

11. England's natural environment has been well-studied at a local, national and UK-wide level. There have also been a number of reports and assessments at these different scales that create a vision for the future of England's natural environment. Making Space for Nature (Lawton *et al*. 2010), the 2010 Natural Environment White Paper, and Biodiversity 2020 all provide strategic aims for biodiversity in England. These national strategies need to be matched with local level plans to ensure that offsetting can act to enhance ecological networks across the country. We have identified where current ecological knowledge and strategy could be brought together to make several aspects of the offset process more robust, particularly in relation to habitat assessment and offset location:

- **Standardising methods to survey biological distinctiveness and habitat condition;**
- **Estimating irreplaceability for the range of UK habitats routinely subject to built development;**
- **Standardising approaches to habitat classification;**
- **Defining suitable receiving areas for biodiversity offsets.**

Scientific evidence gaps

12. Although a lot of ecological knowledge is currently available, there are significant areas where further progress is needed to ensure biodiversity offsetting can be informed by robust evidence both now and in the future. There also needs to be continued work on restoration ecology as a whole, and the lines between research and practice need to be strengthened to ensure any restoration project is supported by a broad evidence base. We have identified a number of areas in relation to biodiversity offsetting where there is currently insufficient ecological knowledge:

    - **The implications of offsetting in particular habitats;**
      In some habitats, the implications of offsetting are unclear. Grasslands and wetlands have been particularly focused on as offset areas across the world, and there have been successes of offsetting these habitats. These areas have also been the focus of ecological research. From 1983-2003, 25% of restoration ecology papers in the Journal of Applied Ecology looked at grasslands (Ormerod, 2003). Other habitats, such as biodiverse brownfield and greenfield sites, have not been as well studied or monitored.

    - **Use of multipliers;**
      Extensive work has been carried out in uncertainty in conservation, and this has recently been extended to offsets (Regan *et al*. 2002; Moilanen *et al.* 2009; Kujala *et al*. 2012). Current proposals for offsetting in England rely on the use of multipliers and habitat banking to address uncertainty. These are widely used tools, but have a loose scientific base. The use of more sophisticated solutions could increase the likelihood of success of any offset scheme. Tools for this are beginning to emerge, but further work to provide solutions and evidence to develop a robust foundation for managing uncertainty is required (Moilanen *et al*. 2009; Pouzols 2012). Uncertainty may not be constant throughout the timescale of an offsetting scheme, and so it is generally more appropriate to assess and manage risks and uncertainty at each stage of a project to improve the likelihood of success. Multipliers should not be used to compensate for situations where there is a risk of offset failure.

    - **Timescales required to restore habitats to functioning ecosystems and ensure no net loss;**
      To assess the full effects of an offsetting project on biodiversity, there needs to be further work to understand the complexity of ecosystems, particularly in understudied areas such as soils. The stability and function of terrestrial ecosystems are strongly dependent on the chemical, physical and biological properties of the soil (Haygarth and Ritz, 2009), and the interactions that develop between above and below ground communities (Hopkins and Gregorich, 2013). Successful restoration of ecosystems to provide the desired function and services therefore relies on successful restoration of the soil environment (Horrocks et al., in press). Evidence suggests that management history can have long lasting effects on soil

chemistry (Dupoey et al., 2002; McLauchlan, 2006;) biology (Buckley and Schmidt 2001; van der Wal et al., 2006; Liiri et al., 2012) and structure (Horn et al, 1995; Baer et al., 2002;) and that these legacy effects can influence subsequent plant species composition (Kopecký and Vojta, 2009) and limit the success of restoration schemes (Walker et al., 2004; Pywell et al., 2007;). Further research is required to enable practitioners to identify and, if possible, minimise the likely magnitude and duration of legacy effects on soils undergoing specific land-use changes (Maharning et al., 2009).

- **Capturing spatial mixes of habitats in biodiversity offset design;**
  Much of England's landscape is comprised of a mosaic of a variety of habitats. Representing this in the design of biodiversity offsets is therefore challenging, and requires in depth knowledge of specific habitat requirements and functioning. Capturing this in any offsetting metric will require further research and evaluation of previous successes and failures.

Climate change will have major effects on the design and implementation of an offsetting policy. Achieving no net loss in biodiversity in light of future changes will require close links with scientific research to ensure that proposed ecological networks remain resilient and supported by realistic overarching strategies.

13. Novel techniques could help bridge some of these gaps. New techniques are emerging to characterise the genetic composition of plant and animal communities at a variety of taxonomic levels (Ji *et al*., 2013) and these could play an increasingly important part in defining target communities for delivery through offsets. These 'metabarcoding' techniques use DNA obtained from a variety of sources including whole organisms, water, soil and parasites (Ficetola *et al*., 2008; Ji *et al.,* 2013; Schnell *et al*., 2012; Yu *et al*., 2012; Yoccoz *et al*., 2012) and can provide extremely useful information regarding assessment of (1) pre and post impact biodiversity at a site (2) the ecological equivalence of a proposed offset site and (3) the success of habitat restoration efforts in the offset site. As science progresses it is important that such advancements in evidence bases are considered in order to ensure that policy development is as robust and up to date as possible.

Need for clarification

14. Scientific research could be used more effectively in offsetting if policies and protocols provided clearer definitions and guidelines. Standardised definitions would allow the potential of projects to be assessed objectively, and their progress monitored on a comparable level. The use of different concepts and definitions in the current peer-review literature leads to difficulties in comparing the success of different offsetting approaches. Clearer guidelines for offsetting will also lead to a reduction in the number of value judgements that need to be made, allowing scientific evidence to be applied more effectively.

15. The choice of baseline can influence the outcomes of an offsetting policy in England in terms of whether or when the objective of no net loss is achieved (Gordon *et al.* 2011; Bull *et al.* [in press]). A standardised baseline definition from which biodiversity loss or gains are measured is therefore essential for offset schemes to be assessed objectively. This will allow achievements in offsets to be quantified, and areas for improvement identified to make any offsetting policies in England more robust in the future.

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Conclusion

16. Any biodiversity offsetting policy implemented in England must be evidence based. The BES notes the limited reference to science in the Green Paper and considers this to be an important omission as ecological science is integral to the development and implementation of an offsetting policy in England. Offsets must be both designed based on best available scientific knowledge, and monitored effectively to ensure performance is objectively assessed.

17. In this report we have highlighted several key areas where the contribution of ecological science is particularly key to informing and developing an offsetting policy, including habitat restorability, understanding uncertainty and assessment and classification of habitat. There is a wealth of ecological knowledge available in England, and this must be utilised in a more effective and collaborative manner to ensure a biodiversity offsetting policy is robust and provides a system of ensuring no net loss of biodiversity across the natural environment.

18. There are a number of practical and theoretical challenges to biodiversity offsetting which can make the delivery of schemes difficult. Clear definitions of metrics and exchange rules around baselines and no net loss to guide offset design and implementation will help minimise the risks surrounding the outcome of offset schemes and allow success to be evaluated.

19. If an offset scheme is implemented, there will be a need to both review practical experiences and carry out further ecological research to ensure that environmental outcomes will be resilient given future changes in environmental conditions and the development landscape. In this report, we have identified a number of key areas where ecological knowledge can be developed to support an offsetting policy that is designed to achieve robust environmental outcomes.

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