Objector Number OBJ0271

Appendices to Proof of Evidence for Richard Barnes

For

M4 CORRIDOR AROUND NEWPORT – PUBLIC LOCAL INQUIRY

Contents:

Appendix A

Natural England Research Report NERR024

Natural England Research Report NERR024

Managing for species: Integrating the needs of England's priority species into habitat management. Part 1 Report

www.naturalengland.org.uk

Woodland habitat requirements

6.336 There are a total of 256 species associated with the Woodland Habitats in England. All of these have been associated with one or more of the priority woodland habitats. One overall broad analysis of all species associated with woodland was undertaken. This gave an overall indication of what niches and habitats are required for UK BAP priority species in woodlands generally.

6.337 Further analyses of species falling into a „general woodland" category was undertaken, along with separate analysis to identify species associated with the following sub-types: wood-pasture and parkland (veteran trees), wet woodland and lowland beech woodland (as these were judged to be the most likely to have assemblages that might require different conditions to the general assessment).

Table 68 Distribution of species across the different priority habitats - Woodland

Woodland habitat	No. of associated UK BAP species
„General woodland" species incorporating: Lowland mixed deciduous Lowland beech and yew Upland oakwood Upland mixed ashwoods Wet woodland	169
Wood-pasture and parkland (veteran trees)	105
Wet woodland	36
Lowland beech woodland	55

6.338 A breakdown of the taxonomic groupings of the 257 species associated with woodland is given below. Woodlands contain a very high number of lower plants (fungi, lichens and bryophytes) and invertebrates when compared to others priority habitats. A high proportion of these are either in the restricted or very restricted category, with nearly forty-five percent found in five or less sites in England.

Table 69 Species numbers across different taxonomic groups - Woodland

Taxonomic group	No. of species
Fungi	42
Lichens	58
Bryophytes	12
Invertebrates	79
Vascular plants	25
Birds	21
Amphibians/reptiles	6
Mammals	13

Appendix B

Welsh Government's Strategy for Woodlands and Trees, 'Woodlands for Wales'

Woodlands for Wales

Llywodraeth Cynulliad Cymru
Welsh Assembly Government

The Welsh Assembly Government's Strategy for Woodlands and Trees

2. Welsh woodlands and trees

Woodlands for Wales concerns all the woodlands that exist in Wales now, and those that will be created in the future, irrespective of size, location or ownership, together with all the trees outside woodland, in both rural and urban areas. Collectively these woodlands and trees make up the resource – a Welsh National Forest – which can be used and developed to meet the social, economic and environmental needs of Wales in the twenty-first century.

Wales is one of the least wooded countries in Europe, with woodland covering only 14 per cent of the land area (Fig 2), compared to the EU average of 37 per cent. The character of woodland in Wales has been influenced by both historic land use and previous government policy, and now most woodland is either:

- conifer woodland, mostly single-species, single-age plantations created during the twentieth century, which generally have been managed by clearfelling and are currently the main source of home-grown timber; or
- native woodland, mostly small and fragmented, often on farms and much of it not actively managed. Not all native woodland is old, but a significant proportion has been continuously wooded for at least 400 years (including some that was more recently converted to non-native plantations). This ancient woodland is irreplaceable (Fig 3).

We, the Welsh Assembly Government, own two-thirds of the conifer woodland (including plantations on Ancient Woodland Sites), but very little of the native woodland and virtually none of the ancient semi-natural woodland (Fig 4).

There are another 15 million trees in Wales outside woodlands, contributing to the economy, rural and urban landscapes, and to our quality of life. More than half of these trees are growing along linear features like hedgerows, riverbanks and roadsides, while the rest are found in orchards, parks, wood pastures and urban areas.

Woodlands and trees are the foundation to support all the other themes of *Woodlands for Wales*. Their nature, quality, distribution and management underpins the whole strategy, and we have identified six key outcomes to strengthen this foundation and ensure that it will be fit to meet the needs of Wales for the next 50 years:

- More woodlands and trees are managed sustainably.
- Woodland ecosystems are healthy and resilient.
- Woodlands are better adapted to deliver a full range of benefits.
- Woodland cover in Wales increases.
- The management of woodland and trees is more closely related to that of other land uses.
- Urban woodlands and trees deliver a full range of benefits.

Appendix C

Treweek, J. et al. (2009) Scoping study for the design and use of biodiversity offsets in an English Context. Final Report to Defra

Scoping study for the design and use of biodiversity offsets in an English Context

Final Report

to

Defra

(Contract NE 0801)

Environmental Statements do not often include sufficiently detailed requirements which could be carried forward into an Environmental Management Plan, meaning that monitoring of implementation would therefore be essential. Furthermore, there are many cases EIA is not required for proposals which might affect, for example, BAP habitat outside of a protected area. Some provision for offsets might therefore be required which did not depend fundamentally on the EIA or SEA process for application of the mitigation hierarchy.

5.3 Provision of Guidance:

At present there is no clear guidance on *how* to do offsets (e.g. what's not offsetable, how additionality can be assured, metrics for measuring loss/gain, locating offsets, trading up, use of multipliers e.t.c.) or under what circumstances they would be appropriate or inappropriate. The complex issues and options surrounding the design and implementation of offsets need to be clarified and standardised if planning authorities are to be able to develop and communicate offset requirements. If a voluntary approach to offsets is considered appropriate, such guidance would have a key role in implementing principles of good practice.

Some of the important issues for which guidance would be required are considered in the following sections. These include:

- defining which habitats and species should be subject to offsetting (see following section);
- determining what constitutes a significant residual adverse effect;
- measuring loss and gain;
- use of multipliers (for example to account for temporal losses during offset delivery);
- equivalence and scope for 'trading up';
- selecting suitable locations/ identifying suitable land for offsets;
- monitoring and enforcement.

5.3.1 Defining thresholds

Biodiversity offsets are neither possible nor appropriate for all biodiversity. It is essential for any system of biodiversity offsets to incorporate safeguards to ensure that offsets are only used when proven techniques for delivery are available and the time required to achieve the desired outcome are realistic. Given this requirement, a possible framework for defining thresholds for application in an English context is set out overleaf in Table 7. This defines the circumstances in which:

- the biodiversity affected is so rare, vulnerable, threatened, or difficult to restore that offsets should not be permitted (Category A on Table 7);
- residual impacts on biodiversity cannot be compensated for using known or proven techniques and are of such magnitude/ significance that offsets should not be permitted (Category A on Table 7);
- there are significant residual impacts on biodiversity but well designed offset projects could be considered appropriate (Category B on Table 7). It is assumed that this category would include all 'biodiversity interests' as inferred in PPS9 - see Section 4.3);
- biodiversity impacts are relatively trivial and either offsets would not be required or a different mechanism should apply (Category C on Table 7; N.B. offsetting may still be appropriate should significant cumulative impacts resulting from a range of recent or proposed developments be reasonably anticipated).

<table>
<tr><th>Table 6</th><th>Sites</th><th>Habitats</th><th>Species</th></tr>
<tr><td>Category A: Offsets not possible or appropriate</td><td>Offset not allowable in any case where the development would:
• Destroy a Natura 2000 or other international site
• Destroy any part of a Natura 2000 site.
• have a significant adverse effect on the integrity of a Natura 2000 site.
• Destroy a SSSI or have a significant adverse effect on its integrity/ ability to achieve favourable condition.
AND compensation for residual impacts is not possible using proven techniques.</td><td>Offset not allowable in any case where the development would:
• Destroy any UK BAP habitat for which national BAP 'maintain extent' target is assessed as "No Loss".
• Destroy any ancient habitats (Ancient woodland, blanket bog or other habitats which are not restorable in 'human' timeframes).
• Destroy any vital habitat networks or stepping stones as covered under the Habitats Regulations and PPS9.
• Destroy any habitat for which no suitable land is available for restoration.
AND compensation for residual impacts is not possible using proven techniques.</td><td>Offset not allowable in any case where the development would:
• Destroy any habitat parcel supporting a key population of a European protected species (i.e. affecting their Favourable Conservation Status).
• Destroy critical feeding, breeding or commuting habitat for a European Protected Species.
• Cause irreversible population decline for any European protected species.
AND compensation for residual impacts is not possible using proven techniques.</td></tr>
<tr><td>Category B: "Goldilocks Zone" - Offset required/ allowable</td><td>An offset would be allowable/ required for:
• Destruction of any part of a Natura 2000 site.
• Developments likely to have significant adverse effects on achievement of integrity of any Natura 2000 site.
• SSSI - destruction of any part.
• Local Wildlife Sites, other than those in Category A - destruction of any part, or significant adverse effect on integrity.
PROVIDED THAT an offset is feasible using proven techniques OR is provided in advance.</td><td>An offset would be allowable/ required for:
• Destruction of UK BAP habitat wherever it occurs (not just in international sites), excluding those in Category A.
• Destruction of any semi-natural habitat [e.g. defined by IHS] > 0.25ha patch size, other than that in Category A.
• Removal of potential for restoration or expansion of BAP habitat identified by a Regional Spatial Strategy or Regional Biodiversity Partnership as part of a BAP restoration or expansion zone (other than that in Category A).
PROVIDED THAT an offset is feasible using proven techniques OR is provided in advance.</td><td>An offset would be allowable/ required for:
• Destruction of any part of a habitat parcel with recent records of a European protected, UK protected, BAP or LBAP species.
• Destruction of any part of a habitat parcel predicted by Habitat Suitability Mapping to support European protected species (other than that in Category A).
PROVIDED THAT an offset is feasible using proven techniques OR is provided in advance.</td></tr>
<tr><td rowspan="2">Category C: No offset or 'streamlined offset' to achieve No Net Loss</td><td colspan="3">Offset may not be required in cases where development would affect other land/ habitat not falling into Categories A or B, Non-BAP habitat, or cases where development does not have an adverse effect on a Local Wildlife Site OR for development proposals not requiring planning consent.</td></tr>
<tr><td colspan="3">Offset may be required in cases where development is likely to give rise to in-combination or cumulative impacts (even if not requiring planning consent), where local wildlife sites are affected or where local communities value the biodiversity affected.</td></tr>
</table>

Appendix D

Natural England, No Net Loss report

Review of the
High Speed 2 No Net Loss in Biodiversity Metric

Citation

This report should be cited as: NATURAL ENGLAND, 2016, Review of the High Speed 2 No Net Loss in Biodiversity Metric.

Chairman’s Foreword

At the request of the House of Commons Select Committee, and commissioned by the Department for Transport on behalf of the Government, Natural England – the Government’s statutory advisor on the natural environment – was asked to report on the differences between the High Speed 2 (HS2) No Net Loss (NNL) Metric and the Defra Biodiversity Offsetting Metric.

I should like to thank the many organisations who worked with us on producing this Report in what was an extremely challenging timescale. Their input through workshops and written comments is greatly appreciated. In presenting the Report, it is worth reiterating that Natural England has sought to produce fair, firm and impartial conclusions and recommendations.

We recognise that some of those conclusions and recommendations will be challenging to HS2 Ltd. But this is one of England’s foremost infrastructure projects of the century. Its benefit and its legacy will be enduring for many years to come, and it can only be right that we seek to ensure that HS2 Ltd provides appropriate levels of mitigation and compensation for the environmental impacts of the project.

I would like to draw out what I see as the three primary points from the Report, all of which are explained in more detail in the Executive Summary and in the main body of the Report.

1. *Ancient Woodland.* Tens of hectares of this valuable and irreplaceable habitat will be unavoidably lost or impacted. The Report makes two clear recommendations. First, that irreplaceable habitat, such as ancient woodland, should be taken out of the HS2 NNL metric. Its inclusion gives the impression that it is tradable or replaceable. Quite simply it is not. Those losses should be reported separately. Second, the Report makes clear that HS2 Ltd needs to be far more ambitious in its aspirations to compensate effectively for unavoidable losses of ancient woodland. To demonstrate that, the Report concludes that for a project of this scale HS2 Ltd should aim to create 30 hectares of new woodland for every hectare lost, where ancient woodland is to be replaced by new woods. There are a number of approaches that could be explored to realise that ambition. If that ambition proves legally impracticable to implement for Phase 1, it certainly should be implemented for Phase 2.

2. *Ongoing evaluation and transparency.* The Report recommends that the HS2 NNL metric calculation be re-run on an iterative basis, in a way that is transparent and easily understood, and reported over the lifetime of the project based on further detailed information as scheme design and implementation progress. This will be essential in ensuring both that the expected levels of compensation are at the right levels and that they are having the desired effect. It will also become more robust as the other recommendations are implemented, in terms of improving the methodology for the calculation itself.

3. *Planning Creatively.* The Report challenges HS2 Ltd to think and plan creatively in order to get the greatest value from compensation provision by looking outside the Bill areas as well as within, and creating some really substantial areas of new habitat.

Natural England is also grateful to HS2 Ltd and the Department for Transport for the opportunity to produce this Report. We look forward to continuing to work closely with HS2 Ltd, where our environmental and wider expertise can be put to good use in this exciting, innovative and long-lasting major project.

Andrew Sells

Chairman, Natural England July 216 (updated 12th October 2016)

Temporary Land Use

16. It is recommended **that options to account for construction timescales within the metric are explored to determine how the HS2 impact arising from temporary land use can be accounted for,** and that more information is provided on the construction phase and temporary land use.

17. Furthermore, it is recommended that **the scoring of low distinctiveness habitats that will be temporarily lost during construction is included in the calculation, in order to fully record biodiversity losses and gains** . In recognition of the fact that some low distinctiveness habitats will not take five years to create (the lowest time to target condition normally applied), whilst others will take five years, HS2 Ltd should consider whether to assume an average that uses a smaller multiplier, or to further separate out the habitat types in order to allocate a more realistic time to target condition.

Understanding the HS2 NNL metric

HS2 is a large and complex project, but different elements of the NNL metric are not transparent. It is recommended:

18. That there is **clarity of objectives, both in terms of what NNL is and the purpose of the HS2 NNL metric**. This will reduce confusion over what does and does not inform compensation provision.

19. That **the NNL methodology is more clearly explained so that it can be more readily understood and repeated by a third-party**. It needs to be clear how and why changes have been made to the Defra metric with sensitivity analysis and examples used to illustrate where ever possible.

20. That the **reporting of the calculations is more transparent**, so that results can be easily understood and links made from the Environmental Statement to the NNL calculation.

21. That **the HS2 NNL metric calculation is re-run on an iterative basis over the lifetime of the Project** based on further detailed information as the scheme design and implementation progress.

22. That **independent quality assurance is built into the future development of the HS2 NNL metric.**

Biodiversity opportunities

23. We recommend that **HS2 Ltd is more ambitious in its aspirations to compensate effectively for unavoidable losses of ancient woodland** and to demonstrate that it recognises the importance of these irreplaceable habitats. **For a project of this scale, it is the judgement of Natural England that HS2 Ltd should aim to create 30 hectares of new woodland for every hectare lost**, where ancient woodland is to be replaced by new woods**.** There are a number of approaches that could be explored to realise that ambition. If that ambition proves legally impracticable to implement for Phase 1, it certainly should be implemented for Phase 2.

24. It is recommended that **HS2 Ltd considers augmenting delivery of compensation outside the 'Bill' area (particularly for ancient woodland)**, and should explore what opportunities such arrangements might offer for realising additional benefits as a result of HS2.

25. In light of the wide ranging issues that using the HS2 NNL metric as an accounting tool has presented, it is recommended that **for Phase 2 of the scheme a metric is applied for biodiversity offsetting purposes, i.e. a tool to inform compensation provision.** It is considered that this would be beneficial for the natural environment, for reporting purposes and for HS2 Ltd.

26. It is recommended that **for Phase 2 the metric should be applied for the purpose of meeting a net gain objective,** in order to fully accord with national policy, rather than simply aiming to achieve NNL.

10.12 Using the HS2 NNL metric a ratio can be calculated by assigning multiplier weightings to ancient woodland and newly created woodland habitat types. Using this approach it is predicted that if HS2 Ltd successfully deliver NNL for impacts on ancient woodland habitats then the compensation ratio (measured in biodiversity units) is approximately 9:1 (see Table 10.1).

10.13 If it is assumed, for the purposes of calculating a 'worst case' ratio, that all ancient woodlands affected by the scheme are in good condition (which is unlikely to be true), and that it is very difficult to create new woodland that adequately compensates for losses of ancient woodland, then the biodiversity unit ratio will be in the order of 60:1 or 30:1, depending whether the HS2 or Defra metric, respectively, is applied (see Table 10.1).

Conclusions

10.14 The level of compensation proposed by HS2 Ltd for ancient woodland is – if judged in terms of a ratio of lost and created habitat – at the upper end of current practice and may well exceed that provided by other development and infrastructure projects.

10.15 The 30:1 ratio cited by the Woodland Trust is assumed to have been derived using the Defra offsetting metric, as illustrated in Table 10.1. There is little evidential basis, as far as we are aware, to justify this or any other specific ratio. However, a commitment to such a ratio would be a clear statement by HS2 Ltd that it recognises the critical importance of ancient woodland and the scale of newly created woodland provided would leave a positive legacy for the natural environment and for the communities along its route. It would also make a significant contribution to the delivering the recommendations of the Lawton report and set the standard for future projects (Lawton *et al.*, 2010).

10.16 There are a number of approaches that could be explored to deliver this additional woodland, including:

- a single large block of new forest delivering multiple objectives; or
- a '100 woods programme' targeted at increasing the size, quality and connectivity of small woodlands (those between 2-5ha) along the route of HS2.

Recommendation

10.17 Natural England noted that ancient woodland is considered to be an irreplaceable habitat and hence it is excluded from the Defra offsetting metric. Where loss of ancient woodland is unavoidable some compensation factor is needed, however there is little evidential basis to justify any one specific ratio (10.15). Nonetheless, one can see what factors are implicit in the Defra pilots and HS2 metrics (Table 10.1) and how these would relate to an area ratio. If it assumed that all ancient woodland is in good condition and very difficult to replace, area based ratios rise to as high as 60:1. Even so, these ratios have more meaning relatively than absolutely. Advice though is needed for a compensation factor, and, after consideration of the above, in the judgement of Natural England, and where ancient woodland is to be replaced by new woods,

Appendix E

JNCC, A Habitats Translocation Policy for Britain

A Habitats Translocation Policy for Britain

Joint Nature Conservation Committee on behalf of
The Countryside Council for Wales, English Nature and Scottish Natural Heritage

Peterborough July 2003

developments and where habitats translocations can be used in partial compensation for those developments that are allowed to proceed.

7. **Conservation policy for habitats translocations**. **The translocation of habitats is considered by the statutory conservation agencies not to be an acceptable alternative to *in situ* conservation**. The statutory conservation agencies will continue to make the strongest possible case against translocating habitats from within SSSIs and from ancient habitats (or other areas with significant biodiversity interest) elsewhere. The principal reasons why habitats translocations are not an acceptable substitute for conserving biodiversity in its original location are summarised under seven headings. The role of habitats translocations for restoring degraded habitats is considered, with the emphasis upon avoiding translocation from SSSIs and other significant sites. Approval of habitats translocation for habitats restoration should be contingent upon demonstrating a net gain for biodiversity as a result of the proposal.

8. **Future data collection and reporting mechanisms**. Habitats translocations should be systematically recorded and the results reported regularly to ensure that proper monitoring is carried out, with the results available to inform future work. There is the need to agree who should be responsible for setting standards for habitats translocations and for making best use of the results.

Appendix F

Translocation and Ancient Woodland, Woodland Trust

Translocation and Ancient Woodland

Luci Ryan

The Woodland Trust

January 2013

Table of Contents

1. Executive Summary

Habitat translocation is sometimes proposed as mitigation or compensation for loss of a habitat, usually to development. Evidence suggests some habitats, such as certain types of grassland, can be successfully translocated. This review looked at the evidence for successful translocation of ancient woodland.

At the heart of this issue is confusion over what is meant by “translocation”. The term is often used in a way that implies ancient woodland can effectively be removed from a site and re-established elsewhere. However, Natural England 2012 states that “ancient woodland as a system cannot be moved.” The complex communities found in ancient woodland are a product of the interaction between unique geographical and historical factors, which cannot be replicated. Current guidance is that habitat translocation is never an acceptable alternative to *in situ* conservation (Natural England 2012, Anderson, 2003, JNCC 2003). Translocation cannot therefore be viewed as mitigation for ancient woodland loss, since the latter is irreplaceable.

Ancient woodland translocation schemes should therefore be more accurately described as translocation or salvage of ancient woodland soils and/or other features, to avoid this confusion. Translocation might, if carried out as a last resort, when loss of the original habitat is completely unavoidable, form part of a package of compensation measures. The question then is how successful this translocation process is, as compared, for example, with simply creating new native woodland on arable or pasture soils.

Habitat translocation is a relatively recent phenomenon, and literature on the subject is scarce. In cases reviewed, monitoring has either been going on for relatively short periods, or was only required for a limited period, which makes robust and rigorous assessment difficult for a habitat such as woodland, that develops over long periods of time. In addition, requirements for monitoring, and in particular publication of this, stipulated through planning consents, often do not appear to be implemented.

The scientific literature suggests translocation of soils may be based on flawed assumptions that they contain a persistent seed bank of ancient woodland plants, and that the complex interactions and associations within these soils can be maintained through the disturbance of the translocation process.

Therefore, there is very little evidence in the public domain relating to the translocation of ancient woodland soil. What there is covers very short time frames and there is a need for further work to be undertaken and published that covers time frames of decades rather than years. There is also a lack of agreed criteria for what constitutes success.

Although there are industry guidelines relating to habitat translocation there is a shortage of published work about the process. This makes it difficult to ascertain if the guidance suggested is appropriate and if habitat translocation as a process is successful.

2. Introduction

Translocation of a habitat is not a commonly undertaken process, however, it is sometimes proposed as mitigation or compensation when habitat may be lost or irrevocably altered by a development.

The Woodland Trust advocates no further loss of ancient woodland, and has for some time held the policy position that translocation is not an appropriate alternative to conservation of an ancient woodland in situ. The Trust carries out planning casework on ancient woods threatened by development, and in some cases an opposing view is expressed by developers and their representatives, citing case studies and evidence. The Trust commissioned this review to objectively assess the evidence in relation to translocation as a measure in proposals that impact on ancient woodland.

The review consisted of a search of policy, scientific literature, practical industry guidance, and case studies relating to habitat translocation, with a particular emphasis on woodland in the UK context. A thorough literature review was carried out using the search terms, translocation, habitat, woodland, ancient woodland and forest. Only twenty publications were found that were relevant to the scope of this review, supporting The Trust's assumption that very little work has been undertaken relating to the translocation of ancient woodland habitat. The earliest publication reviewed was published in 1996 and the latest in 2012.

In 1988 the Nature Conservancy Council produced "The Habitat Transplant Site Register" which listed 48 translocations that had taken place in the UK. Seven of the translocations related to woodland. Unfortunately this register has not been updated since its original publication date (Pers. Comm. Natural England), and it is difficult to obtain precise information about how many subsequent translocations have taken place.

Some habitats can be successfully recreated within relatively short time frames (less than 10 years), such as wetlands, reed beds, salt marshes and pond systems. However, others such as semi-natural grassland and woodland may take hundreds of years before they provide a habitat of a similar quality to that which has been lost (Morris *et al*. 2006). Habitat translocation is often proposed as a method which may speed up the establishment of a habitat to replace that which has been lost.

3. Definition of Translocation

There a number of definitions of habitat translocation, all of which have subtle differences between them.

"Habitat translocation is the process of moving soils with their vegetation and any animals that remain associated with them, in order to rescue habitats that would otherwise be lost due to some kind of development or extraction scheme". (Anderson 2003)

"Habitat translocation is the process of moving soils or substrates with their vegetation and any animals that remain associated with them in order to rescue or salvage habitats that would be lost due to changes in land use, or to restore biodiversity to damaged, degraded or newly created sites." (Box 2003)

"Habitats translocation is here defined as the movement of assemblages of species, particularly plants (including the substrates, such as soil or water, on and in which these species occur) from their original site to a new location." (JNCC 2003).

"Community translocation involves a wholesale removal of an assemblage of species from a site and the attempt to establish it as a functioning community at a new receptor site" (Bullock 1998)

Note the differences between the Anderson and Box definitions and the JNCC definition. Anderson and Box refer to the movement of soil as the primary part of translocation, whereas the JNCC refers to the movement of plants. Bullock (1998) refers to the wholesale removal of an assemblage of species, which in reality is unlikely because habitat translocation usually only relates to vegetation and not the fauna associated with it. In particular, the Box definition differs from the others in referring to the use of translocation methods to improve or restore existing degraded habitats. This may not involve the destruction of one habitat, but uses an existing habitat as a source of plant material for another. However, guidance by the JNCC (2003) suggests that this approach is also generally unacceptable because it would still entail damage to the donor site.

Review of the literature suggests that real-life examples of "ancient woodland translocation" involve removal of soil, and sometimes coppice stools or large pieces of deadwood. Whole trees and associated vegetation are not moved, and only certain protected species of wildlife (e.g. dormice, great-crested newts etc) may be moved.

In addition, Natural England states that "ancient woodland as a system cannot be moved." The complex communities found in ancient woodland are a product of the interaction between unique geographical and historical factors, which cannot be replicated. Current guidance is that habitat translocation is never an acceptable alternative to *in situ* conservation (Natural England 2012, Anderson, 2003).

It would be far more accurate to call the process "translocation of soil and/or features associated with ancient woodland" or "salvage of ancient woodland soil and/or features".

Confusion over what is meant by translocation of ancient woodland may underpin disagreements over whether it can appropriately be suggested as mitigation for loss of ancient woodland. The guidance from Natural England suggests it cannot, but that translocation might, if carried out as a last resort, when loss of the original habitat is completely unavoidable, form part of a package of compensation measures.

The Anderson (2003) Best Practice Guide is the only guidance currently available for developers who wish to undertake habitat translocation (of any habitat, not just ancient woodland). The Guide was commissioned by The Highways Agency as part of a larger project relating to the translocation of habitats. It sets out the minimum standards required for habitat translocation needed to minimise the risk of failure. The guide also makes is clear that *"translocation should be regarded for all sites of high nature conservation value as very much the last resort when all alternative avenues have been explored and discarded"*. Representatives of English Nature sat on the Steering Group that produced this report, but the Best practice Guide is not referenced in the current Natural England Standing Advice for Ancient Woodland (2012), although translocation of ancient woodland is covered in the appendix of this report.

Furthermore, Anderson (2003) states that the significance of effects arising from habitat translocation on high value sites (such as ancient woodland) *"could seriously affect the site's integrity and hence its value, and would generally not be acceptable"*. If translocation is to take place it should be considered *"an appropriate activity to salvage and create a new habitat of some value, albeit a lower one than that lost"*.

Fahselt (2007) raises an interesting point that when translocation of a habitat is proposed as part of a scheme, the idea of habitat destruction tends to become more acceptable. Although Natural England's Standing Advice for ancient woodland (2012) allows for a twin-track approach to planning i.e. an objection can be maintained whilst discussing compensation proposals, there is always a possibility that discussion of translocation of ancient woodland soil as compensation could be viewed as condoning loss of the original site. This should not be the case.

In terms of definitions, a single accepted definition is needed within the planning system that makes it clear that, for ancient woodland at least, complete habitat translocation is not actually possible as mitigation for ancient woodland loss, and that translocation of ancient woodland soils and/or features may be proposed as partial compensation but without prejudice.

The question then becomes one of how successful this translocation process is likely to be, with analysis of costs and benefits against other possible compensation measures.

4. Methodology

4.1. Receptor Site

If translocation is to take place then the developer needs to identify a suitable receptor site. This site needs to replicate the conditions found at the donor site (i.e. the existing ancient woodland) as nearly as possible. It also needs to be the same size, or bigger, to have any chance of minimising biodiversity loss. If the site is not similar in soil type, hydrology, aspect etc. then the prospect of failure of an already high risk process is increased. For example, the translocation of Biggins Wood, Kent in 1988 as part of the Channel Tunnel development is considered to have failed because of the unsuitability of the receptor site in terms of soil and groundwater conditions (Anderson 2003).

The site should also be as close to the existing site as possible and/or connected to similar undisturbed habitat to increase the chances of success (see Cossington Fields example). It is also important to make sure that the proposed receptor site is secure in the long-term, and may not be earmarked for development in the future. Morris *et al* (2006) conclude that if the site of a re-created habitat is significantly different from that of the original habitat then much greater areas of new habitat will be needed to increase the chances of rarer species surviving. Even then, this may not be enough.

4.2. Movement of habitat features

The elements of the habitat to be moved can either be taken up as turves or the soil can be scraped up. The latter is used for the movement of ancient woodland soil. In general, large trees are not moved although in some cases coppice stools have been translocated, and shrubs are generally coppiced before movement. Short stretches of hedgerow associated with ancient woodland have also been moved in at least one example (Stansted Airport). The soil can be moved in such a way as to keep the horizons intact, but generally the horizons are mixed and then spread on the receptor site. Soil should only be translocated in autumn and early winter during normal weather conditions, to minimize damage to soil and plants that may start to grow as early as December.

Scraping the soil off the donor site and then spreading it on the receptor site causes great disruption to the soil profile and creates bare and open patches for ruderal species to colonise and damages the invertebrate community that lives within it. The changes to the soil profile may mean that the habitat is no longer suitable for the very species that the translocation is trying to protect. Work by Bullock (1998) on the translocation of grasslands showed that mixing and spreading of soil caused much larger changes between the donor and receptor sites than use of turves. Interestingly, at one site where spreading was used as the translocation technique, a species rich grassland had grown after seven years, but it bore little resemblance to the donor grassland it was trying to recreate. Compaction of the translocated soil may also be a problem and cause changes to the soil hydrology, which will also affect the species of plant that are able to grow there. Therefore, contractors need to be very careful when spreading translocated soil that it is not then compacted by heavy machinery.

Very little is known about associations between soil microbial communities (bacteria and mycorrhizae) and plants but the mixing up of soil is certainly likely to disrupt any associations that have formed. Any bacteria or mycorhizzae in the soil once mixed may not be compatible with vegetation that is transplanted, and this can cause plant growth to fail (Fahselt 2007, Morris *et al* 2006). This is particularly true of mychorhizzae which are known to be host specific, and may even be obligate for some plant species. These types of relationships are rarely taken into account when a translocation is proposed, but the disruption of them may be one of the reasons why recreation of a viable habitat is so difficult.

Hietalahti *et al* (2005) studied the effect of profile placement (removing the soil as turves) and loose-tipping on the amount of available carbon and nitrogen in the soil. They found that in clay soils that there was no significant increase in carbon and nitrogen mineralisation, but that maintaining the soil profile intact was the best way to conserve soil mineralisation processes close to that of undisturbed woodland. However, this type of soil removal in woodland is extremely difficult due to the presence of large roots and is therefore very expensive. They conclude that the succession of vegetation seen post-translocation is mainly due to changes in temperature, moisture and illumination as well as disturbance of the seed bank, rather than changes to soil mineralisation processes.

There are no guidelines for the number of plants that need to be planted post-translocation or where new plants should be sourced from. Anderson (2003) does recommend that it is beneficial to translocate trees and shrubs from the donor site because they will be of locally native genetic stock, and therefore likely to grow better at the receptor site than horticultural stock. However, Anderson provides no advice as to where new stock should be sourced from. At Biggins Wood nursery grown trees were planted very close together (1.5m) and in rows in order to facilitate the production of shade as quickly as possible. However, these trees were not locally sourced and so were not genetically related to the trees that were removed from the original ancient wood.

Genetic variance within the existing habitat at the donor site does not seem to be taken into account when habitat translocation is proposed. The ability for a species taken from one area to colonise another may well be related to its genetics. It has been shown with individual species translocations that the closer a plant is translocated to other plants with the same genetic make-up then the more likely it is to survive (Fahselt 2007). The reason for this is not understood, but it is thought that there must be some as yet unknown factor in the environment that makes one area more suitable than another. Mixing soil up when translocation takes place may destroy the types of conditions that make an area particularly favourable for a species. Genetic diversity within a community may also be lost during translocation if only some plants are translocated. Without knowing how much genetic diversity exists within the original community, or how it is distributed across the community, the translocation may result in a genetically homogenous population with reduced fitness.

The important point to note here is that in general the rarer the plant species the more complex and poorly understood its environmental requirements are and the more likely the translocation is to fail. Hubbard *et al* (2001) demonstrated that only 15% of translocations involving rare plants were considered successful. Other work by Volis *et al.* (2011) on the translocation of individual species of rare plants also showed that the translocation was most likely to be successful if the plant was translocated to an area containing other rare species. The presence of other rare species was not thought to have a direct effect on the translocated plants, but rather acted as an indicator of an unknown common environmental factor. Translocation of plants to areas seemingly identical in terms of moisture, light, temperature etc. but without other rare species were not as successful. This clearly demonstrates that there are often other factors, as yet undetermined that make one site more suitable than another.

4.2.1. The Seed Bank

Seeds contained within soil are referred to as the seed bank and many people assume that the seeds within a soil profile will be representative of the vegetation growing in the soil. Therefore, moving the soil from a particular habitat to help recreate that habitat in a new location will speed up the process because the soil will contain the seeds of the habitat that has been destroyed. However, this assumption is wrong in the case of ancient woodland and any other habitat that represents the climax of a succession. Plants typical of ancient woodland have reproductive strategies that are associated with undisturbed habitats. Therefore, the seed bank often bears little or no relation to the vegetation growing in the ancient wood. Instead the seed bank tends to be dominated by plants associated with disturbance (ruderal species), for example nettles, brambles and some grasses.

The persistence of ruderal species within the seed bank is well documented, with the most extreme example shown by Plue *et al*. (2008) who demonstrated that despite being forested continuously for over 1600 years, the seed bank beneath the Compiegne forest in France does not reflect the vegetation currently growing, but relates to agricultural land uses that were in place during Roman times. In those areas of the forest where no known Roman occupation had taken place the seed bank still did not represent the vegetation of the ancient forest.

Bossuyt and Honnay (2008) reviewed the use of the seed bank as a source of material to restore habitats and concluded that in the case of woodland and other long term stable plant communities the seed bank is mainly composed of species from earlier successional stages. This explains why receptor sites are often dominated by ruderal species and ancient woodland species that were present in the donor site fail to grow.

Earlier work by Bossuyt (2000) looked at the time needed for a newly planted forest to achieve the same community composition as a neighbouring ancient forest (the locations were no more than 168m apart). The newly planted woodlands studied varied in age from 36 to 125 years old and the ancient woodlands adjacent to them were at least 250 years old. Studies of the seed bank showed it to be dominated by ruderal species. As the age of the new woodland increased then the density of the seed bank decreased because ruderal species decreased as shade increased, but the more shade loving species present in the vegetation did not add seeds to the seed bank. They found that after 100 years the newly planted woodlands had an understorey equal to that of an ancient woodland. However, some ancient woodland species with very low colonisation capacities were not present even after 125 years. These conclusions are supported by a study in the UK by Harmer *et al*. (2001) that found if abandoned arable land is allowed to naturally develop in to woodland it takes 30 years for complete canopy cover to be achieved, but even after 100 years many species that are characteristic of neighbouring woodland have failed to establish.

This work indicates that even if new woodland is directly adjacent to an ancient woodland then at least a century is required before the woodland starts to resemble the ancient woodland, and even then some species may need to be introduced by hand. By translocating soils from ancient woodland the aim is to "seed" the receptor site with ancient woodland species but given that there is often a discrepancy between the seed bank of ancient woodland and the vegetation that is currently present, this work would indicate that translocating soils does not guarantee ancient woodland species will grow.

4.3. Monitoring and reporting

In preparing this report it became apparent that there is a lack of published information on the results of translocation. It is not clear if this is because monitoring is undertaken, but results are not published, or if there is no monitoring being done in the first place. The best practice guidelines state that monitoring and reporting are vital to ensure others learn from the experience of practitioners, yet this does not appear to be occurring.

With regard to woodland translocation Anderson (2003) states that a monitoring period of 20-25 years or more is needed post-translocation. Of the few examples found during the review the longest term of monitoring conducted was 10 years (Cossington Fields). Given the length of time it takes for unmanaged new woodland communities to develop and stabilise (most published work suggests between 80 and 100 years minimum), it is not unreasonable to assume that even if a receptor site is managed it would take more than 10 years for the new woodland to begin to resemble the species composition of the donor site. Much longer monitoring programmes are needed than those currently in place to assess the efficacy of woodland translocation.

In his review of translocations in the UK, Bullock (1998) clearly states that one of the problems of assessing the success of a translocation is the lack of monitoring programmes post-translocation and the lack of explicit objectives pre-translocation. Unfortunately, 15 years after this after was written this still appears to be the case. As part of the monitoring process it may be advisable to have a control plot within the donor site (if any of the donor site remains after translocation) so that changes in vegetation at the receptor site can be more easily related to either the translocation or other environmental factors.

4.4. Management

Once woodland soil has been translocated to the receptor site it will need to be actively managed to ensure that it develops in the way required. If growth of ruderal species is let unchecked they can often outcompete the less generalist woodland species that the translocation is trying to promote. If left unmanaged, the spontaneous disappearance of invasive species is unlikely (Fahselt 2007). Use of herbicides is problematic because they can often kill the species that the translocation is trying to promote, as well as the ones that need to be removed.

Woodlands planted on translocated soils cannot just be left to manage themselves after planting. A thorough Management Plan needs to be produced prior to the translocation taking place, covering such items as thinning of trees, removal of non-native and/or invasive species and replanting of trees and shrubs that have died. In the long-term, the management of woodlands may also include coppicing and/ or grazing in order to replicate the management practices in place at the donor site prior to the translocation taking place.

5. Post-Translocation and criteria for success

What happens when translocation fails and does not result in the ecological community structure envisaged in the planning process? At present there appears to be no safety net in the planning system. In practical terms, if a translocation fails, very little if anything could be done. The original habitats have been removed and the replacement has not worked.

There also does not appear to be a method or criteria in place for determining if a translocation has worked or failed. Box (2003) raised the issue that there needed to be a standard in place for how closely the vegetation needed to resemble the original vegetation for the translocation to be considered a success. Ten later there is still no standard, making it difficult to objectively determine how successful (or not) a translocation has been.

The lack of published information when translocations have taken place make it very difficult for the success or failure of a scheme to be peer reviewed. Furthermore, most translocations have reporting requirements that span short time frames subsequent to the translocations taking place (a maximum of 10 years is the example found as part of this review). After 10 years it is unlikely that the tree canopy will be fully formed and the “new” woodland is unlikely to visually resemble the donor woodland.

Box (2003) proposed that a reference ecosystem be used as a means of evaluating the success of a translocation, for example the UK National Vegetation Classification, and that a translocated habitat should achieve this goal within 10 years. However, his work related specifically to grasslands and a time period of 10 years would be too short for a habitat based on translocated woodland soil. Given that Anderson (2003) suggested a minimum monitoring period of at least 20-25 years for woodland this time frame may be considered more appropriate. However, this in turn raises additional questions about who would be responsible for this monitoring and then what would happen if after 25 years the woodland did not resemble the NVC target set? Furthermore, as it is universally agreed that ancient woodland is irreplaceable even if receptor site did reach the NVC target set, it still could not be classed as ancient woodland.

6. Examples of Ancient Woodland Translocation Projects

Not only are there very few examples of the translocation of ancient woodland soils, but that there are even fewer published articles relating to these translocations. The lack of published, and in particular peer-reviewed data about translocation makes it very difficult to prove or disprove the effectiveness of the process, and a precautionary approach should be taken unless further evidence proves that this is not necessary.

The Review of Habitat Translocation which forms part of the supporting evidence of the Anderson Best Practice Guide (2003) briefly discusses five projects where ancient woodland was translocated; Manchester Airport, Mold Bypass, Biggins Wood, A2/M2 Rochester and Stansted Airport. At the time of publication Anderson concluded that although some translocations appears successful in that plant growth and canopy cover had been established, replication of the complex communities seen in the donor woods was not possible. She also notes that data from the sites is so limited (there was none for Manchester Airport) that it is not possible to draw general conclusions about the effectiveness of translocation ancient woodland. Since the Anderson report (2003) a report has been published on the A2/M2 translocation (Cossington Fields) and a summary of this is included below. A review of Biggins Wood and Brickhouse Wood (not covered in Anderson 2003) are also included because a body of published work is available for these translocations.

6.1. Biggins Wood, Kent

Biggins Wood was a 4 hectare ancient wood in Kent, on the site of the then proposed Channel Tunnel. This is thought to be the first example in the UK of large scale translocation of woodland soil. An earlier translocation had taken place at Stansted Airport but this was a much smaller project relating to an ancient hedge and some soil. The receptor site was significantly smaller than the donor site (1.1ha) and was known not to closely match the donor site even before the translocation took place.

In 1988 the top 200mm of woodland soil was scraped from the donor site and transferred by dump truck to the receptor site, where it was spread over the prepared surface (top soil had been removed) to a depth of 300mm. The idea was that the soil would settle back to its original depth of 200mm. However, 18 months after the translocation the soil had a mean depth of 278mm, which suggested that the soil had been spread at a depth thicker than the 300mm specified.

There was an attempt to match soil from the drier areas of Biggins Wood with the drier parts of the receptor site, and wetter soil with the wetter areas. No attempt was made to move trees and shrubs from the donor site to the receptor site, and the receptor site was densely planted with nursery grown trees in March 1989. The growth of weedy species coupled with drought conditions resulted in the young trees exhibiting moisture stress and a decision was made to use herbicide. Even so, 25 % of the trees died and had to be replanted the following year. Herbicide continued to be used, along with hand weeding, but the latter caused damage to some trees and more trees died. These were replanted in 1991. After 5 years 16 of the woodland species originally recorded in Biggins Wood had disappeared and 93 species not found in the original wood had appeared. The majority of the latter were ruderal species.

Helliwell *et al*. (1996) concluded that for soil translocation to be a success the receptor site should match the donor site, contractors should be very clear about what was expected of them, the receptor site should be planted with trees of local provenance, and that specialist post-translocation maintenance is needed and this may include having to re-introduce specialist woodland species which have been out competed by more persistent ruderal species. In their 1996 paper they deemed that the translocation could be considered a partial success. However, the standard practice guide by Anderson (2003) refers to Biggins Wood as a failure because the receptor site did not match the donor site.

6.2. Brickhouse Wood, Canterbury

Brickhouse Wood was a 5 hectare ancient wood adjacent to a quarry and a landfill north of Canterbury. Two hectares of this wood were translocated to two separate sites to enable the landfill operation to expand. This translocation was unusual in that some of the soil was loose tipped and the rest was moved by soil placement of the intact soil profile. Poor weather conditions at the time of the translocation meant that some of the translocation took place in the autumn of 1998 and the remainder was completed in the spring of 1999. The combination of different soil transfer techniques and timing of the soil transfer enabled comparisons to be made between the different processes.

In reviewing the translocation of Brickhouse Wood, Hietelahti and Buckley (2000) determined that conditions following soil transfer are dramatically different from those in the donor woodland and that this results in the growth of species not seen in the donor wood. Furthermore, the soil transferred in spring resulted in greater disruption to the vegetation that soil transferred in autumn, when most plant species are dormant. Placement of intact soil profiles also resulted in better vegetation re-establishment at the donor site, so long as this was undertaken in the autumn. Their work also looked at damage done to bluebell and wood anemone bulbs and rhizomes during the translocation process. They concluded that careful handling of soil was needed during translocation to ensure that plants were not damaged and that they were planted at the correct depth. In practice, this is difficult to achieve if lose tipping is the method used for translocating the soil.

The study conducted by Hietelahti and Buckley (2000) was undertaken immediately after the translocation and the authors state that further monitoring over an extended period would be required to understand the full impact on species composition. However, no further study of Brickhouse Wood appears to have been published since the original report.

6.3. Cossington Fields – A2/M2 Widening Scheme

Cossington Fields is a new wood created with soils translocated from ancient woodland destroyed as part of the A2/M2 widening scheme in Kent. In addition to translocation of the soil just over 100 coppice stools were also translocated to the receptor site, and planted in a linear fashion across the receptor site. No other vegetation was translocated and the site was planted using 60,000 nursery grown native trees and shrubs. The receptor site had been used as arable land before the translocation, and the planting of trees on the site effectively connected up three other patches of woodland.

Monitoring of the site was conducted on a regular basis for ten years, and the results of this monitoring were published by in 2012 by Hyder Consulting. One of the most interesting parts of the Cossington Fields translocation is that at the same time Cossington Fields was planted, the developers planted a new wood, Great Crabbles Wood, without using translocated soil. This means that comparisons can be made between the two types of new wood, which does not appear to have been done anywhere else before. Like Cossington Fields, Great Crabbles Woods is adjacent to existing woodland, and so both new woods have increased connectivity in the landscape.

The results from the surveys carried out between 2000 and 2009 show the presence of some ancient woodland indicator species at Cossington Fields, but none at Great Crabbles Wood. This indicates that the use of translocated soil has speeded up the formation of a woodland plant community. However, it should be noted that some woodland species have been lost completely from Cossington Fields since monitoring began, and others have declined in number. The results from Great Crabbles Wood fit very well with other published work relating to the recruitment of ancient woodland indicator species into newly planted woodland in that it takes much longer than ten years for species typical of woodland to appear, even if the new woodland is connected to an existing ancient wood (see Bossuyt *et al*. 2000, Harmer *et al*. 2001, Jirova *et al*. 2012)

Ten years is a very short time to determine the success of this sort of project and the consultants responsible for the monitoring at Cossington Fields recommended that further surveys are carried out in 10 years time (i.e. 2019). This will help to determine if the differences between Cossington Fields and Great Crabbles Wood are still apparent, and whether those woodland indicator species present in 2009 at Cossington Fields are still present twenty years after the soil was translocated.

Invertebrates, birds, bats, badgers, dormice and fungi were also all surveyed as part of the monitoring of the A2/M2 development. Invertebrate communities are known to be severely impacted by disturbance, but unfortunately are rarely routinely monitored. In this instance species composition at Cossington Fields was found to be more diverse than that at Great Crabbles Wood, but neither assemblage of invertebrates represented the baseline survey conducted in 2000. Again the consultant has assumed that the translocation of the ancient woodland soil is the cause of the more diverse assemblage of species seen at Cossington Field. However, they also concur that 10 years is to short a time at be certain that this is the case, and additional monitoring will be necessary.

The monitoring and management of Cossington Fields represents the most through example of published work relating to translocation of ancient woodland soil found during the production of this report. If the site continues to be monitored it will provide very useful information on the value of translocating soils as well as a direct comparison between a standard new woodland, and a new woodland on translocated soil.

7. Conclusion

Some habitats may be successfully translocated *in toto*, but these would be transient and highly dynamic habitats, and ancient woodland does not fall within this category. There is no evidence that stable climax communities, such as ancient woodland, can be recreated though habitat translocation, and current policy guidance is that it cannot.

The lack of clarity over definition of “ancient woodland translocation” may be at the heart of disagreements over its use. Development proposals may suggest it as mitigation of ancient woodland loss, directly stating or implying that the habitat can be re-created. In practice, it actually involves salvage or translocation of individual elements of an ancient wood, such as soils and coppice stools, rather than the whole.

Features that make an ancient woodland special are not only driven by ecological factors. Long-term management of the woodland that has taken place over centuries will have also have had an impact on the woodland we see today. The time scales involved in recreating this type of habitat are so long than we can never be certain that the process will be successful. Furthermore, the original woodland may have developed under climatic conditions that are different to those seen today, and on soils that have not been subjected to the same processes, such as intensive agriculture, so even under ideal environmental conditions the woodland that develops will not be a replica of the original.

In terms of accurately describing this process during planning it may be better to refer to it as “translocation of ancient woodland soil” or “salvage of ancient woodland soil”, but not “translocation of ancient woodland” as this is misleading.

A single accepted definition is needed within the planning system that makes it clear that, for ancient woodland at least, complete habitat translocation is not actually possible as mitigation for ancient woodland loss, and that translocation of ancient woodland soils and/or features may be proposed as partial compensation but without prejudice.

The question then is not whether an ancient wood can be moved or recreated – it clearly cannot – but whether, in cases where loss cannot be avoided, translocation of some elements of the habitat is appropriate and likely to bring biodiversity benefits.

There are a number of issues around this: first, there are no clear criteria for determining whether or not this type of salvage operation can be deemed a success, which means that clear objectives cannot be set for any proposed translocation. Second, there is still relatively little practical experience of the process. Third, monitoring and reporting of existing cases is inadequate.

The literature does suggest a number of drawbacks to the salvage or "translocation" of ancient woodland features, in relation to lack of a persistent seed bank of ancient woodland specialists, and lack of knowledge around plant/soil interactions. While some successes are reported in terms of translocation of individual species such as dormouse, this does not equal successful creation of a fully functioning woodland habitat. Some preliminary monitoring eg at Cossington Fields suggests that moving soil may speed up the recruitment of specialist woodland plants. However, even the consultants responsible for the monitoring accept that ten years is too short a time frame to be certain that this is the case. Although Cossington Fields is an excellent example of very thorough management and monitoring of a translocation process it should not be taken as irrefutable proof that translocating ancient woodland soil is a successful process. Much more research needs to be undertaken over longer periods of time to provide support to this claim and further work is needed to compare the success of woodlands grown on translocated soil compared to woodlands planted on in situ soil.

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Appendix G

Corney et al 2008, Impacts of nearby development on the ecology of ancient woodland

Impacts of nearby development on the ecology of ancient woodland

Corney, P.M.[1], Smithers, R.J. [2], Kirby, J.S. [1], Peterken, G.F. [3], Le Duc, M.G. [4] & Marrs, R.H. [4]

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4.2.4 Invasion by non-native plants

Most non-native plants are ecologically inconsequential in a semi-natural context, but some may pose a substantial threat to ancient woodland in the UK (e.g. rhododendron *Rhododendron ponticum*, cherry laurel *Prunus laurocerasus*, Japanese knotweed *Fallopia japonica*, and Indian balsam *Impatiens glandulifera*). They may form extremely dense stands capable of completely excluding native species, eliminating natural regeneration, and dominating large areas of woodland (Cross 1981; Dehnen-Schmutz *et al.* 2004).

Invasive plants may 'escape' from gardens or be dumped in nearby woodland. Housing may also make ancient woods more vulnerable to invasion by fragmenting semi-natural landscapes (With 2002), increasing availability of nutrients (Zink *et al.* 1995) and creating open, light areas and edges, all of which may favour introduced plant species. Some or all of these effects may be associated with new housing development located near to ancient woodland.

A New Zealand study on the movement of garden plants into 18 native forest areas of varying sizes found the number of non-native species in woodland was significantly related to adjacent settlement attributes: housing proximity; density; age; and presence in gardens of non-native plants (Sullivan *et al.* 2005). The number of houses within 250m of a forest area, alone, explained two thirds of the variation in the number of non-native plants in these forests.

4.2.5 Cumulative effects

Chemical effects, disturbance, fragmentation and invasion by non-native plants associated with housing development are likely to have a cumulative impact on nearby ancient woods. Disturbance associated with nearby housing is likely to have a greater impact on wildlife where conditions are already ecologically-stressed (in terms of habitat or food availability) as a result of fragmentation. This in turn is likely to favour the spread of non-native plant species. Consequently, increasing residential development has been shown to lead to declining species richness and diversity (Smith & Wachob 2006).

4.3 Transport

This section focuses on the effects of nearby transport corridors on ancient woodland. Although literature was sought on a range of transportation types (including roads, motorways, railways, docks, harbours, canals, airports and aerodromes), only searches for motorways, roads and, to a lesser extent, railways, returned specific results.

The area over which significant ecological effects extend outwards from a road is typically many times wider than the road surface and associated roadsides (Forman & Alexander 1998; Hawbaker *et al.* 2006). It often extends into adjacent woodland areas. A recent analysis of data from over 100 woodland sites in Britain found that roads through or adjacent to woods were more important than all other recorded boundary variables (e.g. presence of hedges) and grazing variables (e.g. presence of sheep or deer) in explaining the composition of woodland ground flora (Corney *et al.* 2006). They were also very important relative to site-level climatic and spatial variables.

Hypotheses in chapter 3 that it is reasonable to assume may relate to this section are described below.

4.3.1 Chemical effects

Likely chemical and disturbance effects of road construction and operation are illustrated in Figure 4.1.

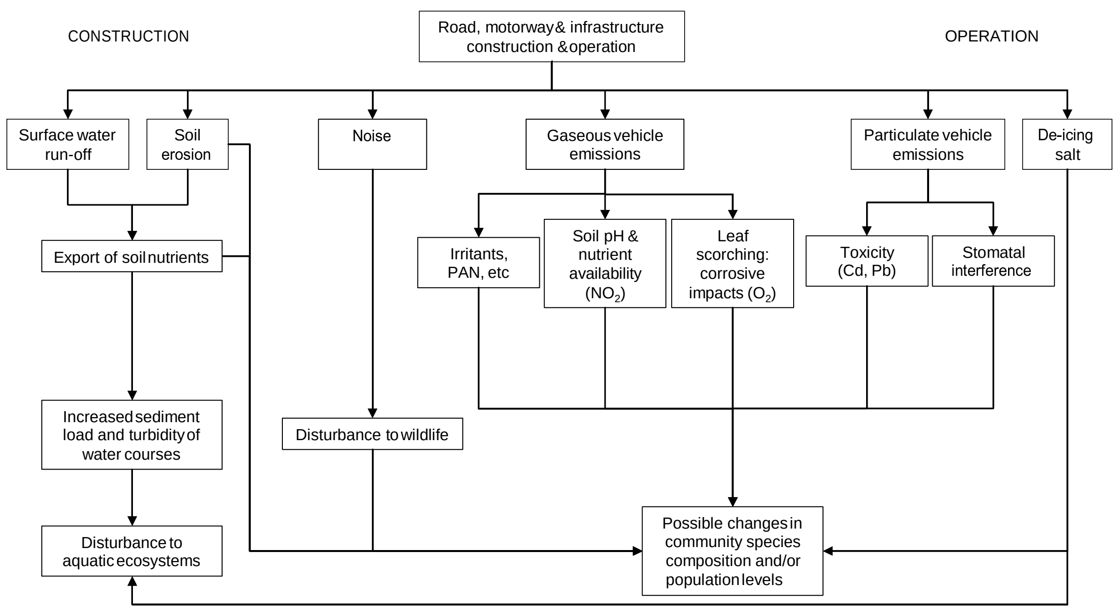

Figure 4.1. The major chemical and disturbance effects of road development.
Redrawn from Sheate & Taylor (1990)

Application of herbicides and spillage of hazardous substances during construction may have local impacts on adjacent woodland. However, pollution connected with road and motorway development arises principally during operation, i.e. once these are in use (see Figure 4.1). Chemical pollutants connected with road use include road-salt, and gaseous and particulate emissions (Bernhardt *et al.* 2004; Sheate & Taylor 1990).

Chemicals used to de-ice roads in winter are primarily salts; sodium chloride, calcium chloride, or calcium magnesium acetate (Forman & Alexander 1998). The use of these chemicals increases sodium, calcium and magnesium to levels in the immediate environment that may be toxic to many species of plants, fish and aquatic organisms. Road salt is a substantial deterrent to amphibian road crossing and may also be harmful to roadside woodland amphibian populations, such as great-crested newts *Triturus cristatus* (Gent & Gibson 2003).

Road salt application, together with nitrogen from vehicle exhausts, has been shown to significantly alter the species composition and abundance of ground flora in woodland alongside roads in Germany (Bernhardt *et al.* 2004). Airborne sodium chloride is known to cause leaf injury to trees over 100m from roads, particularly in down-wind and down-slope directions (Forman & Alexander 1998).

Harmful gaseous emissions from vehicles include hydrocarbons, carbon monoxide, peroxyacetyl nitrate (PAN), nitric oxide and nitrogen dioxide, which can produce ozone (Forman & Alexander 1998).

In the UK, nitrogen oxides are produced primarily by vehicle emissions (NEGTAP 2001). Moderate concentrations of nitrogen oxides produce both positive and negative plant growth responses, depending on species sensitivity to, or ability to capitalise on, increased nutrient load. Woodland is not a habitat in which nitrogen availability limits growth, as compared to nutrient poor habitats, such as moorland, but increasing nitrogen can alter the outcome of competitive interactions, changing the character of woodland vegetation, in terms of species composition (Sheate & Taylor 1990). There is recent evidence from woods across Britain that species increasing in cover are more likely to be associated with high nutrient status conditions. Some species have shown consistent increases (e.g. nettle *Urtica dioica*, rough meadow grass *Poa trivialis* and pendulous sedge *Carex pendula*) or decreases in abundance correlated with modelled nitrogen changes (Kirby *et al.* 2005)..

Nitrogen oxides can contribute to local acid rain, lowering soil pH levels, which have been linked to reduced tree root development and increased drought susceptibility in European forests (Matzner & Murach 1995). Research conducted in a wood at Rothamstead Experimental Station (UK) found that nitrogen deposition and consequent acidification reduces the total number of plant species and alters soil microbial processes (Goulding *et al.* 1998). Soil acidification can also reduce nutrient availability and increase solubility of deposited metals, such as lead. Nutrient deficiency combined with increased metal toxicity creates conditions of ecological stress for plant communities (Sheate & Taylor 1990). This changes the composition of the ground flora and may lead to competitive dominance by one or a few species able to tolerate harsh road-edge conditions (Sheate & Taylor 1990). However, there is evidence that, in general, woodland soils in the UK have become less acidic over recent years (Kirby *et al.* 2005).

Importantly, nitrogen deposition can stimulate increased decomposition and mineralisation rates, particularly if soil pH increases. Acting as positive feedbacks, these mechanisms further increase nitrogen availability in the soil, enhancing the nutrient effect of nitrogen deposition (NEGTAP 2001).

Turbulence caused by the passage of vehicles distributes particles emitted in vehicle exhausts into nearby vegetation. A study undertaken in woodland adjacent to the M6 motorway in England found that engine particles were concentrated on tree leaf surfaces adjacent to the road corridor, which became less frequent with increasing distance from the road. However, particles were sometimes carried for 200m or more through or over woodland, particularly in the direction of the prevailing wind (Freer-Smith *et al.* 1997). Ground-level air pollution of this kind can cause a substantial reduction in the health of trees, such as sessile oak *Quercus petraea* and beech *Fagus sylvatica*.

Trees in woodland next to two motorways surveyed in England (M62 & M40) showed increased defoliation, insect damage and poor crown condition (Bignal *et al.* 2007). This effect of roadside pollution extended approximately 100m into adjacent woods. This is consistent with the measured profile of nitrogen dioxide, which declined to background levels at about 100m (Bignal *et al.* 2007).

A study of woodland areas around the M25/M40 motorway junction in England has demonstrated that pollution from roads affects invertebrates (bagmoth *Luffia ferchaultella* larvae) that eat lichens (Sims & Lacey 2000; Sims & Reynolds 1999). Roadside pollution significantly reduced the feeding rate of these invertebrates on lichen gathered from areas adjacent to the motorways, compared to control sites. The causative agents of this effect included heavy metals such as lead, chromium, vanadium, and copper. The effect was directionally dependent on the prevailing winds but was spread over some 2km (Sims & Lacey 2000).

4.3.2 Disturbance

Large roads and motorways are associated with direct mortality of species (Forman & Alexander 1998). Increased noise pollution and activity disturbs wildlife and may ultimately lead to changes in community composition (see Figure 4.1). Removing adjacent trees or vegetation for road construction may also have hydrological impacts on remaining woodland. These may include reduced rainfall interception, increased surface water run-off and soil erosion, which may have long-term impacts on any remaining or adjacent woodland (Sheate & Taylor 1990).

Road kill is probably the leading cause of direct, human-linked animal mortality today (Forman & Alexander 1998). Wildlife casualty rates can be important locally (Mumme *et al.* 2000). Recent data demonstrates that road kills affect over 20 species of mammals in the UK, with approximately 10,000 sightings of mammal casualties each year between 2001 and 2004 (Mammals Trust UK 2005). Data collected in 2005 indicates that mammal road casualties of all species are significantly linked to the quantity of nearby woodland habitat (Mammals Trust UK 2006).

Nesting birds avoid habitat adjacent to well-used tracks, roads and motorways (Brotons & Herrando 2001; Foppen & Reijnen 1994; Ingelfinger & Anderson 2004; Reijnen & Foppen 1994; Reijnen & Foppen 1995; Reijnen *et al.* 1997). Other effects on birds can be quite subtle, for example, through acoustic masking of birdsong by traffic (Warren *et al.* 2006). Indeed bird species most affected appear to have song frequencies closest to that of traffic noise (Rheindt 2003).

Disrupted hydrological function caused by road building, particularly cutting construction, is likely to have long-term effects upon adjacent woodland, which could be considerable and possibly irreversible. Cuttings or drained slopes may lead to a reduced water supply in nearby woodland, resulting in loss of trees and/or changes in species composition. The scale of these physical impacts will depend upon the degree to which the local water table level and the main supply of water to the wood are affected (Sheate & Taylor 1990). For example, premature death of many trees occurred at the Woodland Trust's Hardwick Wood, near Plympton, Devon on land alongside a large road cutting created when the A38 trunk road was widened.

4.3.3 Fragmentation

The primary effects of road incursion into woodland are illustrated in Figure 4.2. The isolation effects identified are also relevant to roads routed across land between woods.

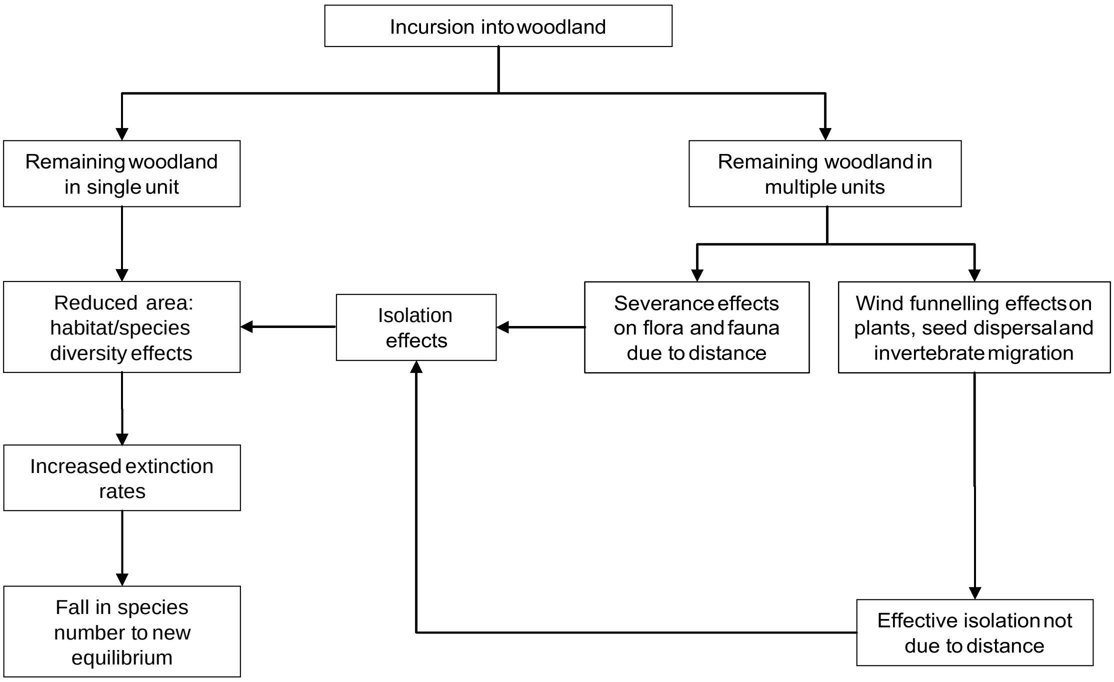

Figure 4.2. Species diversity effects as a result of woodland incursion. Redrawn from Sheate & Taylor (1990)

Woodland fragments, with small area to perimeter ratios, are particularly susceptible to physical impacts resulting from road development, as they lack core area, i.e. area that is unaffected by negative edge effects from adjacent land-use (Woodland Trust 2000). The isolation of large woods with a spatially varied structure that support a diversity of wildlife may also have a disproportionate impact at a landscape scale (Sheate & Taylor 1990).

Some species may take advantage of habitats alongside transport corridors (e.g. verges or hedgerows). These may act as valuable movement pathways for some species, where conditions are suitable (Mata *et al.* 2008), particularly in otherwise highly-arable landscapes. However, transport corridors can act as a barrier to dispersal and migration of species that seek to cross them (Pirnat 2000) and the open habitats along their margins (Koivula & Vermeulen 2005). Many species are known to be affected, for example: bumblebees; woodland ground beetles; and deer (Bhattacharya *et al.* 2003; Dyer *et al.* 2002; Koivula & Vermeulen 2005).

Motorways are major barriers due to their width, speed and frequency of traffic and wind-funnelling, which affects wind-dispersed invertebrate and plant populations (Sheate & Taylor 1990). This is also highly likely to be true of other substantial linear transport corridors (e.g. new railways and airport runways).

By reducing the amount of habitat that can be reached from a particular habitat patch (Eigenbrod *et al.* 2008), new transport corridors may isolate nearby woods, with consequent and inevitable species losses (Sheate & Taylor 1990). In this way, transport corridors may have landscape-scale effects, sub-dividing populations, with demographic and probably long-term genetic consequences (Forman & Alexander 1998).

4.3.4 Invasion by non-native plants

Non-native plant species are often abundant in roadside vegetation (Hansen & Clevenger 2005; Olander *et al.* 1998). Roadsides can act as a reservoir for such plants, facilitating the ongoing spread of non-native species into nearby wildlife habitats (Forman & Alexander 1998). Non-native species were found to be frequent up to 25m from road and railway corridor edges in forests in Banff National Park in Canada (Hansen & Clevenger 2005) with some species present more than 50m away.

4.3.5 Cumulative effects

Disturbance from noise, vibration, visual queues, pollution, and predators can cumulatively lead to species avoiding habitats. For example, pied flycatcher *Ficedula hypoleuca* breeding success in wooded areas in Finland decreases within 130m of nearby roads (Kuitunen *et al.* 2003). Woodland specialist birds in sagebrush steppe habitat adjacent to dirt and paved roads associated with natural gas extraction in Wyoming, USA are similarly affected (Ingelfinger & Anderson 2004). They are encountered less frequently within 100m of roads, even where traffic is light (less than 12 cars per day).

Disturbance to woodland birds associated with roads is particularly well-documented in the Netherlands (Foppen & Reijnen 1994; Reijnen & Foppen 1994; Reijnen & Foppen 1995; Reijnen *et al.* 1997). Effects measured for over forty woodland bird species vary between species and traffic usage but have been detected 40-1,500m from roads with 10,000 cars per day and 70-2,800m from roads with 60,000 cars per day. Reductions in the abundance of birds of 20-98 per cent have been recorded within 250m of roads, depending on species. Brotons & Herrando (2001) also documented reduced bird occurrence in wooded fragments up to 2,000m (2km) away from a main road. These studies consistently record that forest specialist bird species are more affected than generalists. It is conceivable that disturbance also deters deer from frequenting roadside woods to some degree, which may have a beneficial impact where browsing would otherwise be detrimental.

Transport corridors remove habitat, alter adjacent areas, and interrupt and redirect species movement. They subdivide wildlife populations, foster spread of invasive species, change hydrology and water courses and increase human use of adjacent areas (Hawbaker *et al.* 2006). Although the cumulative effect of these factors is not particularly well-documented, it is unquestionable that transport developments have a potentially profound effect on nearby ancient woods.

4.4 Commercial and industrial development

This section focuses on the effects of nearby commercial and industrial development on ancient woodland, including offices, factories, warehousing, and plant machinery. The wider effects of urbanisation are dealt with in 4.13. Hypotheses in chapter 3 that it is reasonable to assume may relate are described below.

4.4.1 Chemical effects

Atmospheric pollutants from some industrial processes may affect woodland over a wide area. Relative to other habitats, woods are especially vulnerable because they provide tall, large and ‘rough’ surface areas for deposition and assimilation of airborne substances (Fowler *et al.* 1999; Tamm & Cowling 1977). As a result, soil acidification and pollutant particulate concentrations, sampled along transects away from pollutant sources, have been found to be significantly higher in woodland than in non-wooded sites (Fernandez-Sanjurjo *et al.* 1998; Rieuwerts & Farago 1996).

Appendix H

IEEM and ALGE, Offsetting the impact of development on biodiversity

JOINT CONSULTATION

Response Document

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Offsetting the impact of development on biodiversity (Defra)

31 January 2011

IEEM Company Limited by Guarantee, No. 2639067
Established 1991

<u>IEEM and ALGE comments on:</u>
<u>Offsetting the impact of development on biodiversity</u>

General Comments

IEEM and ALGE recognise the vulnerabilities in the current planning system with regards to restoring, protecting and enhancing biodiversity and ecosystem services and that it is right to explore alternatives. Biodiversity offsetting offers interesting opportunities but there are concerns about its widespread use.

IEEM and ALGE emphasize the fact that offsetting is a response to a development proposal brought forward in a planning application. It is therefore crucial that one role that is spelt out for the Local Planning Authority is that of deciding whether the need and policy context for the development is actually sufficient to justify a scheme that will result in residual impacts in the first place, that then require offsetting. This role has to be part and parcel of the determination, otherwise there is the risk that others (offset providers and environmental bankers with a vested interest) automatically assume an offset is appropriate where in fact there is no justification.

The potential for funding offsetting is through development projects or plans. This is separate from (and in addition to) agri-environment/rural development programme money, but could be seen to support it by enhancing links and higher concentrations of habitats compared with much farmland.

Biodiversity offsetting could potentially be used as a development and a conservation tool *provided* it delivers **net gains** for biodiversity – no net loss is an insufficient argument for offsetting. Measuring no net loss is fraught with difficulties and unlikely to embrace all species. Seeking more than no net loss will err on the side of caution as partial compensation for all the species that will not be replicated in the new habitats.

Biodiversity offsetting assumes that we have the ability to create, restore, and enhance ecosystems and communities but this is only true in some circumstances and over different timescales. In many cases, habitat creation and restoration is still an experimental area and the difficulties and uncertainties are amplified by the impact of climate change. Some habitats can not be created (peatlands, ancient woodland) within achievable timescales. Others are more amenable to creation (reed beds, ponds, neutral grassland in appropriate conditions). These differences need to be taken into consideration when considering offsetting.

In the UK we have identified and protected only a sample of our best ecosystems. There are many areas of high biodiversity value that currently have no protection. We cannot assume that all areas of high biodiversity value have been identified (although there is a wealth of data that we can draw on). This potentially poses a risk to the acceptance of biodiversity offsetting as a tool, if unprotected areas of high biodiversity value are then vulnerable to offsetting proposals.

Biodiversity offsetting may be introduced at a time of significant changes to the operating environment such as deregulation and a drive to a localism agenda, moves to other market mechanisms, loss of ecological expertise within local government through public spending cuts and likely radical changes to the way that statutory nature conservation is delivered. This must not be used as a reason to reduce the level of protection for species and habitats and could, at the same time, present serious challenges to the successful introduction of a biodiversity offsetting scheme.