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

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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)

Executive Summary

Introduction

1. This review, instigated at the request of the House of Commons Select Committee, and commissioned by the Department for Transport on behalf of the Government, aims to review the differences between the High Speed 2 (HS2) metric and the Defra Biodiversity offsetting metric and report as to whether they are justifiable and reasonable.

2. In order to meet the specified deadline this independent review is generally limited to the areas identified by the Select Committee, but identifies some wider issues of concern. It was not possible to re-run the metric models within the time frame of the review.

Context

3. A biodiversity metric is a way of giving a unit value to biodiversity so that it can be 'traded' for the purposes of compensation. The HS2 No Net Loss (NNL) metric is based on the Defra biodiversity offsetting metric. The HS2 metric is intended as a **tool for accounting** for HS2 Ltd's ambition of NNL, whilst the Defra metric was designed to **inform decisions** on biodiversity compensation provision. To account for a large scale infrastructure project HS2 Ltd made adaptations to the Defra metric, which was primarily designed for use on smaller scale development proposals.

4. This review concludes that, in principle, it was legitimate to adapt this approach as the Defra metric is not an 'industry standard'. However, changes ought to be transparent and evidence-based. The review found that using a metric designed to inform decision making as an accounting tool leads to confusion when trying to distinguish between the two.

5. The current NNL calculation identifies a deficit of approximately 3% in biodiversity units, and the review recommendations are likely to increase this.

Recommendations

<u>Irreplaceable habitats and designated sites</u>

6. It is recommended **that irreplaceable habitats and protected areas, notably ancient woodland and Sites of Special Scientific Interest (SSSIs), are taken out of the HS2 NNL metric** as their inclusion gives the impression of tradability for non-tradable biodiversity resources. It is right to quantify all biodiversity losses arising from the project but in these instances losses should not be accounted for using a metric methodology. A separate recognition of these losses, that considers and makes explicit compensation, would be more appropriate. Opportunities in relation to ancient woodland compensation provision are described below.

Enhancement of existing ancient woodland habitat

7. Restoring existing ancient woodland habitat to compensate for woodland losses is consistent with established conservation practice. It is recommended that **ancient woodland enhancement is documented in a separate report, and HS2 Ltd provide certainty on management sustainability and the design and monitoring of condition targets**.

Position in an ecological network

8. The aspiration to incorporate the spatial context of a habitat within its wider network, as part of the HS2 metric, is commendable. However, the current means of adding a connectivity factor is overly simplistic, and there is a risk that the multiplier adds bias by favouring a narrow set of criteria whilst other valid criteria are not incorporated. It is recommended that **the 'position in an ecological network' multiplier is removed from the HS2 metric**.

9. It is recommended that **Natural England coordinates the development of a new spatial multiplier** that is better grounded in the growing body of scientific and expert knowledge on ecological connectivity, and which would be applicable to small developments as well as large infrastructure projects.

Target condition and scoring of hedgerows post-construction

10. It is recommended that HS2 Ltd should **maintain the separate hedgerow accounting line in the NNL metric, and concluded that it is reasonable for HS2 Ltd to assume that a 'good' condition can be achieved for newly created hedgerows**.

11. It is recommended that **HS2 Ltd assess the distinctiveness of hedgerows pre and post construction** in line with current practice in place in Warwickshire.

12. It is recommended that **Natural England coordinates the development of an updated multiplier model for hedgerow condition** in light of improved understanding of hedgerow management and experiences of applying the metric in the Defra pilot areas.

Time to Target Condition

13. The HS2 metric is more optimistic than the Defra metric, in terms of the predicted time to achieve a target condition. It is recommended **that the professional expertise of the consultant ecologists should be backed up by published evidence to justify the time to target condition values**.

14. The time to target condition in the Defra metric cannot be consistently applied in a metric calculation due to the wide variance in the lower and upper limits of the time to reach target condition. It is recommended **that an independent group develops a set of values to use for different habitats being created, restored or enhanced that could add to the existing guidance on biodiversity metrics**. Natural England would be willing to coordinate this group.

15. It is recommended **that an indication of which habitat types are expected to achieve a good condition weighting within the project period is placed in the public domain.**

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.

Contents

1: Introduction

Background

1.1 The Government is committed to halting overall loss in biodiversity by 2020. In line with Government policy, the High Speed 2 development project (HS2) is seeking to achieve no net loss (NNL) in biodiversity at a route wide level. To demonstrate NNL, HS2 Ltd has developed a methodology to account for losses and gains in biodiversity. This is based on the metric approach used in the Defra biodiversity offsetting pilot (Defra, 2012).

1.2 HS2 Ltd is not using its adapted metric to determine the amount of compensation to provide. This is set out in the Environmental Statement for HS2 and elsewhere (HS2, 2013 & 2015).

1.3 In adapting the metric to assess overall NNL of biodiversity HS2 Ltd has included additional measures for irreplaceable habitats (notably Ancient Woodland and Lowland Fen), which were excluded from the Defra metric (Defra, 2012), and for habitat position in an ecological network. The methodology was published alongside the Environmental Statement in 2013 (HS2, 2013). In January 2016, HS2 Ltd published the interim results (dated December 2015) of their NNL calculation and an updated methodology. This described further changes to the metric since 2013 and reported an interim result of a shortfall of 1,066 biodiversity units (HS2, 2015a).

1.4 In 2015 and early 2016, the House of Commons HS2 Select Committee heard concerns from petitioners about the effect of the changes HS2 Ltd introduced to the original Defra metric. The Select Committee recommended "*the Promoter to identify an independent third party arbiter to review the different net loss metrics and publish its findings so that HS2 Ltd can be challenged on its figures if appropriate. Natural England is one possibility*."

1.5 Government accepted the recommendation and asked Natural England, as the statutory nature conservation adviser, to undertake the Review.

Principles of the Review

1.6 Natural England agreed with the Department for Transport to apply the following principles to the Review:

A: To involve those petitioners who made the most significant points during the Select Committee process.

B: That the review would be transparent and informed by stakeholders and experts when determining the issues and evidence to be considered.

C: The review would be selective, focusing on the differences between the HS2 and the Defra metrics.

D: The review would evaluate evidence provided by petitioners, other experts and HS2 Ltd and identify points of divergence in professional judgment and interpretation.

E: Natural England will have editorial control of the report and it will represent Natural England's conclusions based on assessment of the evidence.

F: It will be a 'fleet of foot' review, available in time to inform the House of Lords and a re-run of the no net loss calculation (if this is required).

Scope of the Review

1.7 The environmental assessment of biodiversity losses is set out within the Environmental Statement (HS2, 2013 & 2015) and the approach to compensation design has been informed by the findings of the Environmental Statement. Consideration of the content of the Environmental Statement **is not part** of the scope of the Review.

1.8 The scope of the Review focuses on the differences between the Defra Biodiversity offset metric and the HS2 NNL metric. The overarching question that sets the scope of the Review relates to the differences of choices within metrics. It is:

Question: Do the changes to the Defra metric provide an appropriate and justifiable basis, in terms of ecological principles, on which to evaluate whether HS2 Ltd has achieved NNL?

1.9 Drawing on Select Committee and Petitioner documentation, the most significant areas of challenge were identified to provide focus to the Review. Five key areas were identified in relation to the primary question, these are:

- Irreplaceable habitats and designated sites.
- Enhancement of existing ancient woodland habitat to contribute to biodiversity units post construction.
- Position in an ecological network.
- Changes to target condition and scoring of hedgerows, post-construction.
- How time to target condition and temporary land use is incorporated.

1.10 Each of these areas of challenge is underpinned by a set of *a priori* key questions against which the evidence was considered. The key questions are set out in the areas of challenge chapters (see Chapters 3 – 8).

1.11 A secondary cross-cutting question for the review to consider relates to the transparency and level of detail of the reporting. It is:

Question: Is HS2 Ltd's reporting of NNL sufficiently clear, detailed and accessible to generate confidence in the results?

(see Chapter 9)

Approach to the Review

1.12 Time was a particular constraint for this review. The draft scope of the Review was shared with stakeholders who provided comment. The over-arching and

primary questions were agreed and, because of feedback, some of the detailed secondary questions were modified and wider issues were also identified.

1.13 Literature searches were conducted, and there was an open call to interested stakeholders to submit documented evidence for consideration. Two stakeholder workshops took place for the explicit purpose of gathering oral evidence (expert opinion). Given the scope of the Review and the varied nature of the evidence base, it draws upon available scientific research, government publications, expert publications and expert opinion as well as examples of good practice.

2: Context

Scene setting for biodiversity metrics

2.1 This chapter provides background information to explain the origins and use of biodiversity metrics, and to also identify the origins of the term '**no net loss of biodiversity'**, both of which should aid the reader in understanding chapters of the Report where particular aspects of the HS2 metric are considered.

2.2 HS2 Ltd is seeking to secure no net loss (NNL) for biodiversity, and has used an adapted version of the Defra biodiversity offsetting metric in order to demonstrate how this commitment has been realised. The Defra metric was developed by Defra with technical input from Natural England and a number of other external technical experts. The development of the Defra Metric was primarily driven by recognition of the need to pilot how biodiversity offsetting might be embedded in the local planning system.

The Defra Metric

2.3 The Defra pilots ran between 2012 and 2014 in six pilot areas across England. The objective of biodiversity offsetting is to compensate for biodiversity loss arising from development at one location with conservation gains elsewhere (Habib *et al.* 2013), as opposed to providing biodiversity compensation within a development site. This approach to compensating for biodiversity loss is a relatively new concept. Whilst it is not standard practice, it is now applied in varying forms by a number of countries e.g. Germany, Australia and France, and its use continues to gather momentum and research interest e.g. Miller *et al.*, 2015;Quétier *et al.*, 2013; and Albrecht, 2014.

2.4 Biodiversity offsetting metrics seek to quantify the biodiversity value of a loss, to enable trading to take place so that biodiversity of an equivalent value is provided as compensation. The metric provides a means of calculating biodiversity value for trading purposes. The Defra metric only includes replaceable habitat and habitats outside protected areas. Metrics cannot fully account for all aspects of biodiversity value, but rather they provide a mechanism for demonstrating consistent trading between losses and gains. This inherently means that additional ecological considerations are likely to be necessary over and above the application of a metric (Mareno-Mateos *et al.*, 2013), particularly in relation to individual species requirements (Natural England, 2016 & 2016a). For example, grassland that only has grass and no herbaceous flowering plants does not provide habitat niches for many 'grassland invertebrates' (Woodcock *et al.*, 2016) and a woodland without old trees and dead wood does not provide habitat niches for some saproxylic beetles.

2.5 The Defra metric was developed for use by the pilot local planning authorities, and was not designed for an extensive linear infrastructure scheme. There are examples of the use of a biodiversity offsetting metric for large linear infrastructure schemes in other countries, for example the French high speed rail link to connect Le Mans and Rennes (Lemeri & Briot, 2016).

2.6 A biodiversity metric operates on the principle of applying scores to each of the various elements of biodiversity value, and then undertaking a multiplication sum using each of those scores (see below), in order to produce a number that represents biodiversity value. The value is normally referred to in terms of **biodiversity units**. The biodiversity value of compensation habitat needs to equal or exceed that lost to achieve NNL.

Example 1

If 5 hectares of habitat which has a distinctive score of 4 and a condition score of 2 is lost then the biodiversity value of this habitat can be calculated as follows:

Area (ha) x Distinctiveness x Condition = Biodiversity unit value of habitat

5 x 4 x 2 = 40 biodiversity units

This means that the compensation provided needs to total 40 units to achieve NNL.

2.7 There are risks associated with creating new habitat as compensation: delivery risks and spatial risks (Defra, 2012). Where risk factors are considered relevant, additional multipliers can be used to adjust the number of biodiversity units needed to achieve NNL. Multipliers that take account of risk and uncertainties are often referred to as 'risk' multipliers in biodiversity metrics

Example 2

Example 1 is repeated here with a 'risk multiplier' to take account of the time it takes to create new habitat. In this example the Defra offset pilot metric (Defra, 2012) for 'time to target condition' of 10 years is used, i.e. 1.4.

Area (ha) x Distinctiveness x Condition x Time to Target Condition = Biodiversity unit value of habitat

5 x 4 x 2 x 1.4 = 56 biodiversity units

In this example, including a risk multiplier increases the number of units required to achieve NNL by 16.

2.8 Biodiversity metrics also have particular 'rules' to ensure consistency and prevent loopholes that could result in biodiversity of lesser value being created (so-called 'trading down'). Metric rules can vary from application to application, but there are a number of rules that appear to be universally agreed amongst practitioners, including the need for trading to either be 'like for like, or better' (BBOP, 2012). In other words, if the same type of biodiversity cannot be provided, something better should be provided in its place. For the Defra pilot metric, this rule is incorporated by the requirement that a more 'distinctive' habitat is created where the same habitat type cannot be provided, with distinctiveness categories being assigned on the basis of parameters such as: species richness; diversity; rarity; and the degree to which habitat supports species rarely found in other habitats (Defra, 2012).

The HS2 Metric

2.9 In seeking to secure NNL, HS2 Ltd decided to use the Defra metric as a basis for their accounting tool. HS2 Ltd modified the Defra metric in order to suit their requirements. The adaptations made by HS2 Ltd to the Defra metric include: removing some of the original multipliers; adding in new multipliers; altering the scoring attributed to some multipliers; and modifying some of the commonly applied rules. HS2 Ltd justify the adaptations in light of professional judgement and scheme specific requirements, as well as the unique use of the metric as an accounting tool rather than an offsetting tool. HS2 Ltd also state that some of the adaptations were made in light of feedback on the Defra metric, and to ensure that the HS2 metric suits a landscape scale linear project (HS2, 2015a), for which the Defra metric was not specifically designed.

Contrast between HS2 and Defra metrics

2.10 The use of a biodiversity offsetting metric is normally to identify what quantity of biodiversity value needs to be created in order to compensate for losses that, having followed the mitigation hierarchy, cannot be avoided or mitigated. Designated wildlife sites are compensated on a bespoke basis, having regard for the specific site losses and contribution of the site to the network of designated sites. Unprotected habitats of biodiversity value in the wider landscape are compensated for in a more generic way in response to duties within National Planning Policy and general duties to have regard for biodiversity within the Natural Environment and Rural Communities (NERC) Act 2006. Given the continued declines in biodiversity, it is apparent that our wider biodiversity assets continue to be lost (Oliver *et al.*, 2015). Despite the legislation and policy in place to protect them (Defra, 2014), and in the absence of an applied approach to quantifying losses and stipulating how compensation can be adequately provided, a decline in biodiversity assets continues. The Defra metric sought to fulfil this role as a tool that decision makers could use in order to meet legislative and policy requirements whilst preventing delay and unnecessary burden for developers (Defra, 2012; Sullivan & Hannis, 2015). The Defra metric is, therefore, a tool to **inform compensation delivery requirements.**

2.11 In contrast to this, HS2 Ltd has used an adapted form of the Defra metric in order to **make an account of the compensation being provided**, with that compensation provision already having been determined through separate processes as described in the Environmental Statements (HS2, 2013 & 2015). This application of the metric is therefore intended to be a retrospective accounting tool rather than driving the nature of compensation being provided (HS2, 2015a; HS2, 2016). Whilst this Review focusses on the use of the HS2 metric for accounting, it includes some discussion on the application of biodiversity metrics for both purposes, and therefore distinguishes the use as either an 'accounting' metric or an 'offsetting' metric. A lack of evidence relating to the use of a biodiversity metric as an accounting metric elsewhere indicates that HS2 Ltd's approach is novel and previously untested.

2.12 The following table provides a summary of the full suite of adaptations that have been made for the HS2 metric, comparing those adaptations with the original Defra metric. The information relating to the adaptations has been taken from the HS2 methodology documents (HS2, 2013; HS2 2015a), and the guidance provided by Defra for applying the Defra metric (Defra, 2012a). The table

identifies when HS2 Ltd made the adaptation in the evolution of their methodology, and highlights which adaptations are the subject of this Review.

Table 2.1: Changes made by HS2 Ltd to the Defra metric

HS2 NNL metric	2013 or 2015 adaptation	Defra biodiversity offsetting metric	Review consideration
Accounting tool for compensation already determined	2013	Offsetting tool to inform the level and nature of compensation provision required	Yes – indirectly considered as part of other topics
Inclusion of irreplaceable habitats, with the addition of a new 'very high' score for such habitats under the distinctiveness multiplier	2013	Exclusion of replaceable habitats. For use with replaceable habitats only	Yes – a direct Review topic
Inclusion of designated sites - SSSIs	2013	Exclusion of any designated site. For use with local level biodiversity loss only	Yes – a direct Review topic
Assigning a high distinctiveness score to all habitats that contribute to open mosaic habitat on previously developed land (habitat of principal importance)	2013	Includes a general rule that where there are primary and secondary habitat types within a parcel, the highest distinctiveness score takes precedence. Assigns a high distinctiveness score to open mosaic habitat on previously developed land (habitat of principal importance), so any lower scoring secondary habitat types would not be counted in any event	No
Automatically assigns a 'poor' condition weighting to all habitats of a low distinctiveness type	2013	Requires habitat condition to be scored as a multiplier for all parcels, irrespective of scores for other multipliers	No
Addition of a 'position in the ecological network' multiplier to give weight to particular criteria used to define beneficial contribution to ecological networks. Removes the Defra spatial multiplier	2013	Does not include a position in the ecological network multiplier, but does include an incentivising spatial multiplier to encourage offsetting locally and in accordance with local biodiversity objectives	Yes – a direct Review topic
Only assigns a moderate condition to habitats being created where they are a high distinctiveness habitat being created/re-created. Additional removal of the on-step change in condition rule in the Defra metric	2013	Does not place any restrictions on condition scoring other than that habitat offsets can only claim a change in condition of one step from the current condition of the existing habitat (e.g. if an existing habitat is of poor condition, the offset provided on that land parcel can only be calculated as a moderate condition)	Yes – indirectly considered as part of other topics

Both hedgerows and watercourses are treated as linear features in the HS2 metric	2013	Only provides instruction for treating hedgerows as linear features in the Defra metric	No
Inclusion of a specific means of accounting for ancient woodland enhancement as part of a compensation package for ancient woodland loss, which includes use of the new 'very high' distinctiveness score	2015	The Defra metric allows for both habitat creation and enhancement of existing habitat, with appropriate scores allocated that only take account of the increased biodiversity value from the existing situation. As ancient woodland is an irreplaceable habitat and therefore not included in the Defra metric, no specific consideration is given	Yes – a direct Review topic
Reedbeds created for engineering purposes, e.g. related to water filtration are assumed to be of moderate distinctiveness, rather than the high distinctiveness category normally assigned to such habitats	2015	Assigns a high distinctiveness score to reedbeds, and does not make any distinction relating to their purpose	No
Assigns a blanket moderate condition score to all scrub habitat, both that being lost and that being created	2015	Defra metric does not give specific guidance on condition scoring for scrub habitat	No
Following the 2013 adaptation restricting all high distinctiveness habitat to a moderate condition score for created habitats, this rule is further adapted to exclude hedgerows, thus allowing them to achieve a high condition score in the HS2 metric	2015	Does not place any restrictions on condition scoring other than that habitat offsets can only claim a change in condition of one step from the current condition of the existing habitat (e.g. if an existing habitat is of poor condition, the offset provided on that land parcel can only be calculated as a moderate condition)	Yes – a direct Review topic

2.13 Decision makers will often secure biodiversity compensation in the absence of a metric to either inform or account for compensation decisions where, after applying the mitigation hierarchy, a residual biodiversity loss remains but it is concluded that the benefits of the development outweigh the harm. Where a biodiversity metric is not used, compensation can be designed on a bespoke basis, having regard for the nature of the loss, or applying a simple ratio. A greater ratio of gain to loss may be applied in order to take account of factors such as time lag between loss and fully functioning compensation habitat, or where there are risks relating to full delivery of compensation. A decision maker may in such instances apply a simple ratio of 10ha of habitat to be created for every 1ha of habitat lost, for example. Whilst basic ratios might be put in place to account for some of the factors that biodiversity metrics also incorporate in the various multipliers, it is important to note that biodiversity metrics cannot be directly compared to compensation ratios, and attempts to cross reference or compare between the two are misleading.

The no net loss (NNL) of biodiversity concept

2.14 The use of a metric for the purposes of seeking to achieve NNL in biodiversity raises fundamental issues in terms of whether NNL is being achieved with a retrofitted accounting tool rather than a metric informing the level of compensation required. Some of the adaptations make changes that question whether NNL is being demonstrated, particularly as the HS2 metric brings in habitat types considered un-tradable (irreplaceable) and some adaptations lack apparent evidence-based rationale.

2.15 The NNL objective stems from a number of international and national policy sources. The European Union (EU) Biodiversity Strategy (EU, 2011) states that to avoid a net loss of biodiversity and ecosystem services, damages resulting from human activities must be balanced by at least equivalent gains. The England Biodiversity 2020 strategy (Defra, 2011) similarly requires progression from a position of net biodiversity loss to net gain, by supporting healthy, well-functioning ecosystems and coherent ecological networks. That is also embedded in the National Planning Policy Framework (NPPF; DCLG, 2012), requiring sustainable development to minimise impacts on biodiversity and provide net gains where possible. It is in this policy context that decision makers and industry have set biodiversity objectives such as the HS2 commitment of **seeking to secure NNL**.

2.16 HS2 Ltd has adopted the use of the metric as an accounting tool in order to demonstrate how the NNL commitment has been fulfilled. The commitment is to 'seek' to secure, with use of the metric as an accounting tool simply providing an account of what has been done. Its use for such an objective, therefore, does not automatically require any shortfall to be rectified. Rather, HS2 Ltd should refer back to the requirements of the NPPF (DCLG, 2012) to address any identified short-fall in relation to this issue.

2.17 In preparing this Review, it has been necessary to explore what is meant by 'no net loss for biodiversity.' HS2 Ltd documentation does not provide an explanation of what HS2 Ltd defines as NNL in order to underpin their approach (HS2, 2015a; HS2, 2016). The findings and recommendations of the Review are therefore based on the authors' interpretation of what is meant by NNL, in light of available evidence, and Government policy and publications.

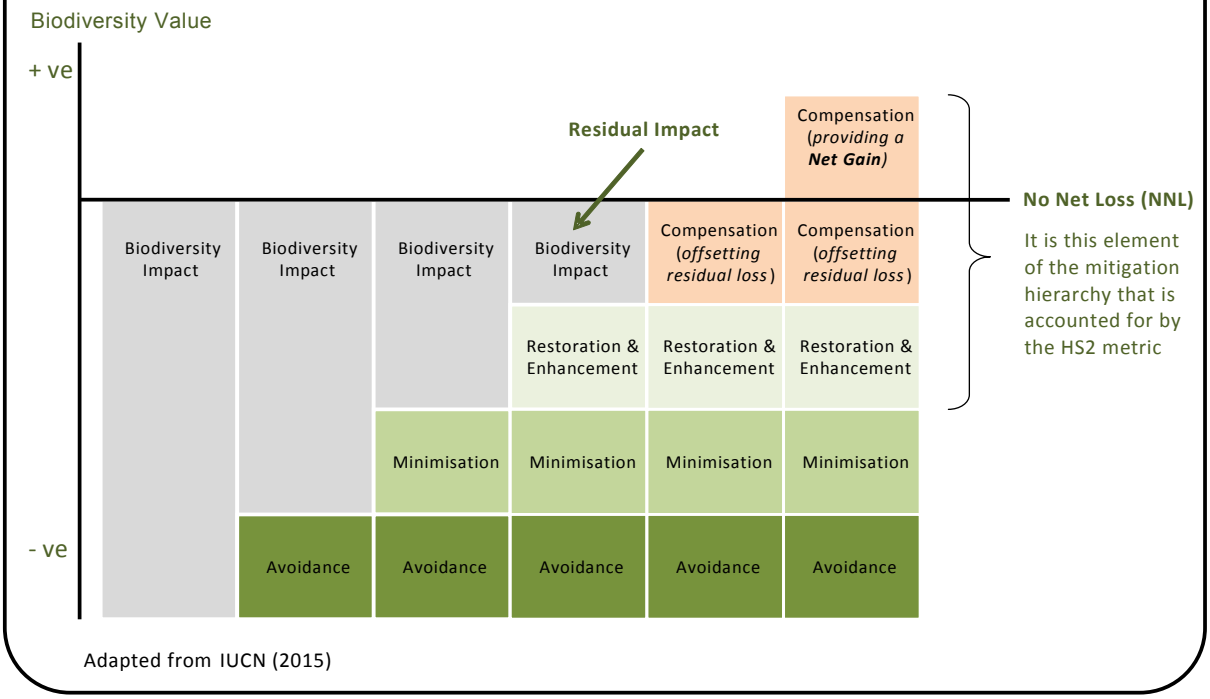
2.18 The authors consider that the definition used by the IUCN is helpful in this respect (IUCN, 2015). Amended slightly to reflect the UK situation, this asserts that the biodiversity goal for a project seeking to achieve 'no-net-loss' is for the negative biodiversity impacts caused by the project to be balanced by biodiversity gains through compensation measures implemented in the locality of the project. The biodiversity changes need to be evaluated against a baseline (e.g. a reference point or trajectory without the project occurring, or prior to the project occurring) of the relevant biodiversity features (in this case the habitats) being impacted by the project. From a conservation perspective, achieving a NNL goal for a given project ultimately (i.e. in the long-term) means no net reduction in the:

- diversity within and among species and vegetation types;
- long–term viability of species and vegetation types; and

- functioning of species assemblages and ecosystems, including ecological and evolutionary processes.

2.19 The 'net' in NNL acknowledges that some biodiversity losses at the development site are inevitable (at least in the short-term), and that biodiversity gains may not be perfectly balanced in regards to the time, space, or type of biodiversity impacted. This is due to the inherent limitations of information available on the species and ecosystems involved. It is recommended that offsetting metrics overcompensate for residual impacts to ensure a NNL outcome for biodiversity. Risk multipliers can be used to set the level of overcompensation in a standardised and quantifiable way (Defra, 2012). For a NNL goal to be achieved credibly, a project needs to follow the 'mitigation hierarchy', which is UK government policy (DCLG, 2012) for managing biodiversity risk and realizing conservation opportunities in development projects. The relationship between the mitigation hierarchy and the NNL is summarised in Figure 2.1.

Figure 2.1: The Mitigation Hierarchy and No-Net-Loss



Adapted from IUCN (2015)

3: Irreplaceable habitats and designated sites

3.1 In the Defra biodiversity offset metric irreplaceable habitats and SSSIs are excluded from the approach. In contrast, HS2 Ltd included both in its calculation with the aim of producing a single, all-inclusive no net loss (NNL) calculation allowing a comparison of all biodiversity losses and gains occurring as a consequence of the scheme (HS2, 2016).

3.2 For the purposes of the HS2 NNL calculation, metrics were created that allocated biodiversity units for losses to habitats deemed to be irreplaceable, defined as ancient woodland, lowland fen and mature lowland heathland[1], and SSSIs. Mature lowland heathland was also highlighted as irreplaceable, but is a habitat type not affected by the project. The Review refers to both ancient semi natural woodland (ASNW) and plantation on an ancient woodland site (PAWS), with both being covered under the general term of 'ancient woodland.'

3.3 The primary question in respect of this difference in the two metrics was:

Question: What is the underpinning rationale for irreplaceable habitats and designated sites in the HS2 NNL metric?

What is the basis for including or excluding irreplaceable habitats?

3.4 The notion of irreplaceability is a socio-political construct driven by science and societal values (Devictor, 2015; Morena-Mateos *et al.*, 2015; Coralie *et al.*, 2015). In theory it could be argued that all habitats are replaceable, given sufficient time and resources. For example, if you have a 500 year period ancient woodland may be replaceable (Defra, 2012). But in reality, time and resources are not limitless and, in the consideration of biodiversity metrics and compensation, it is recognised that some habitats cannot be replaced within the timeframe of a project (Githuri *et al.*, 2015).

3.5 A further dimension to the notion of irreplaceability is the idea of equivalence. When offsetting for compensation is undertaken the accepted rule is 'like for like' or 'better.' In other words, there are equivalent biodiversity and ecosystem services pre and post-construction. This idea of equivalence is important when thinking about irreplaceable habitats because equivalent biodiversity and ecosystem services cannot be recreated in a project time frame. To give a simple illustrative example, if a herb rich chalk grassland were compensated for by the creation of a rye grass football pitch they would not be equivalent.

3.6 HS2 Ltd has recognised that some habitats are irreplaceable (HS2, 2015a; HS2, 2016). The timeframe for the NNL calculation used by HS2 is 32 years (HS2,

[1] The pre-construction areas of these three irreplaceable habitats are: 45.49 ha, 3.78 ha and 0 ha, for ancient woodland (excluding plantation on ancient woodland sites), lowland fen and lowland heathland, respectively.

2015a), and where habitats cannot be adequately recreated in this period they are treated as irreplaceable in the HS2 metric (HS2, 2015a). There is no agreed national list of irreplaceable habitats to use in offsetting projects in England[2]. Importantly HS2 Ltd has included fens, which are diverse and complex systems, as irreplaceable (HS2, 2016).

3.7 The Defra metric advises that irreplaceable habitats should be considered separately from the metric (Defra, 2012). The very notion of irreplaceability means such habitats are not tradable. HS2 Ltd is clear in stating that its NNL metric is being used as an accounting tool, and not to drive the level of compensation (HS2, 2015a; HS2, 2016). However, the inclusion of irreplaceable habitats in the HS2 NNL metric inadvertently conflates tradable (i.e. replaceable) habitats with irreplaceable habitats, because the biodiversity unit values from the calculations are summed to give a single end figure. Expert evidence (IUCN, 2016; BBOP, 2012; Natural England, 2016 & 2016a) suggests that calculating pre- and post-impact biodiversity units in this way leads to a perceived trade-off between the two. For example, in the post-construction calculation 100 biodiversity units generated by irreplaceable habitat may be traded against 80 units generated by a replaceable habitat resulting in a perceived deficit of only 20 units, therefore masking the actual loss of irreplaceable habitat.

3.8 During this review we could not identify an ecological rationale for such a perceived trade-off, or for this difference from the Defra approach. Case studies in the literature treat irreplaceable habitats differentially from tradable habitats (Kujala *et al.* 2015). Expert evidence supported a clear distinction between replaceable and irreplaceable habitats in metric calculations (Natural England, 2016 & 2016a).

What ecological principles inform the scoring of ancient woodland?

3.9 Wrapped up in the notion of irreplaceable habitats is the idea that they are highly distinctive and therefore difficult to recreate (or restore). Distinctiveness itself is a somewhat fuzzy concept for which there is no universally agreed method of measurement. In essence, distinctiveness within a metric is a proxy for biodiversity richness and ecosystem functionality.

3.10 Within the HS2 NNL metric there is an assumption that all ASNW sites are of higher distinctiveness than PAWS, and in consequence PAWS habitat is assigned a lower distinctiveness score ('high' = 6) than ASNW ('very high' = 8).

3.11 The Review has not been able to identify an ecological rationale to support these assumptions, in either the methodology or the recent 2016 submission of evidence to the Review (HS2, 2013; HS2, 2015a; HS2, 2016). A large proportion of PAWS have been planted with predominantly broad-leaved species (Forestry Commission, 2015). Evidence indicates that these can be as distinctive as a good ASNW (Peterken and Game, 1984; Kirby, 1988). Equally, a poor ASNW may be less distinctive than a PAWS. There are a variety of contributory factors affecting the richness of an ancient woodland site including its size, soil type and

[2] It was a recommendation of the final report of the Defra offsetting pilot that Defra and Natural England produce updated technical guidance on biodiversity offsetting including an updated list of habitats that are defined as 'irreplaceable' (Defra 2014).

grazing pressure (Kirby, 1988), and much of the species richness occurs in the rides (Peterken and Francis, 1999).

3.12 As constructed, the HS2 NNL metric lacks sufficient granularity to differentiate between the distinctiveness within ancient woodland sites (including both ASNW and PAWS). The reasoning for aggregating the treatment of site types by HS2 Ltd at this pre-construction stage is reasonable. However, the available evidence and current policy, for example Ancient Woodland Standing Advice (Natural England & Forestry Commission, 2014) indicates that ASNW and PAWS should be afforded the same distinctiveness score.

3.13 At a later stage in the development process when detailed survey data is available, ASNW and PAWS woodland could be disaggregated to site level, and individual distinctiveness scores applied in a refinement of the NNL metric as an accounting tool. Expanding the distinctiveness metric to allow more nuanced scoring took place in one of the Defra offsetting pilot studies, and a revision to a 5 level scale was a recommendation of the final report for the Pilot (Defra, 2014)

What is the basis for treatment of SSSIs in the metric?

3.14 The HS2 NNL metric uses the final compensation package agreed with Natural England to calculate the biodiversity unit value of protected areas, namely SSSIs, within the scheme following the same methodology as other habitats. Protected areas are considered to be non-tradable habitat in the Defra offset metric (Defra, 2012a), and as such do not feature in biodiversity unit calculations. So is it reasonable for HS2 Ltd to have included SSSI habitat within its calculations?

3.15 Githiru *et al.* (2015) suggest that protected areas fall within the notion of irreplaceability, and as such are not tradable and, therefore, should not feature in biodiversity metrics. This is consistent with the Defra metric approach (Defra, 2012a), and with the European Commission's approach to NNL, which identifies NNL as a requirement for biodiversity compensation outside that which is covered by EU Directives[3].

3.16 This Review has not been able to identify an ecological rationale to support the assumption for including SSSIs in the metric, in either the methodology or the recent 2016 submission of evidence to this Review (HS2 2013, HS2 2015a, HS2 2016). The available evidence indicates that SSSIs should not be considered as tradable habitat but be treated as irreplaceable habitat. While HS2 Ltd (2016) recognises the significance of SSSIs, inclusion within the metric presents a risk of conflation and potentially setting an undesirable precedent, though HS2 Ltd is clear that this is not their intent (HS2, 2016).

[3] As described on the European Commission's website, accessed on 29 June 2016 ec.europa.eu/environment/nature/biodiversity/nnl/index_en.htm

Conclusions

3.17 From the available evidence, we conclude that there is no reasonable rationale to justify the inclusion of irreplaceable habitats and SSSIs in the HS2 NNL metric.

3.18 More specifically, the weight of evidence leads us to conclude that irreplaceable habitats, such as ancient woodland, should be treated in a distinct way that avoids conflation with tradable habitats and/or perceived trade-off.

3.19 An ecological rationale for differential treatment of ASNW and PAWS could not be identified, leading us to conclude that these sites should receive the same metric scores at the gross level. However, we recognise that as more detailed survey evidence becomes available there is an opportunity to refine metric scores to reflect variation in the actual condition of habitats within the 'very high' distinctiveness category.

3.20 Evidence, government policy, and international practice lead us to conclude that there is no basis for the inclusion of protected area (SSSI) habitats in the NNL metric. Rather, the weight of evidence indicates that these should be treated separately to avoid conflation with tradable habitats.

Recommendation

3.21 With consideration to alternative ways of reporting losses and compensation measures with the overall aim of reporting NNL, the evidence leads us to a clear recommendation **that irreplaceable habitats and protected areas, notably ancient woodland and Sites of Special Scientific Interest (SSSIs)are taken out of HS2 NNL metric reporting and published separately.** Separate non-metric reporting for irreplaceable habitats and protected areas should include an explanation of how and where compensation is being provided and the considerations given to site-by-site compensation design, and should set that compensation in the context of legislation and national planning policy.

4: Enhancement of existing ancient woodland habitat

4.1 The HS2 metric takes account of habitat enhancement of ancient woodland as well as habitat creation, unlike the Defra metric. The primary question relating to the difference in the metrics was:

Question: Is it appropriate for enhancement of existing ancient woodland habitat to contribute to the calculation of biodiversity units post-construction?

4.2 HS2 Ltd is proposing to take account of enhanced ancient woodland in the NNL metric. It should be noted that Natural England's standing advice on ancient woodlands does allow for enhancement as part of a compensation package. The issue called into question here is HS2 Ltd's approach to compensation for unavoidable losses of ancient woodland, which includes enhancement of existing ancient woodland elsewhere.

4.3 Within the metric it is assumed that because of enhancement measures the condition score of ancient woodland will increase to 3, and that there is a short time to target condition (or five years). These assumptions combine to have a multiplier effect that increases post-construction biodiversity units.

4.4 In the first instance, is it appropriate to give weight to the enhancement of existing ancient woodland over the biodiversity value of newly created woodland? Studies, such as those by Fuentes-Montemayer *et al.* (2012), Fratmann *et al.* (2013), and Nascimbene *et al.* (2013) indicate that management interventions on existing woodland will lead to improved biodiversity richness, diversity and ecosystem function. Expert evidence, based on practical experience, supports this view (Natural England 2016 & 2016a). In principle, it is appropriate for HS2 Ltd to give weight to enhancement of existing ancient woodland.

4.5 Within the HS2 NNL metric, enhanced retained habitat condition value is increased by one step e.g. low to moderate condition (1-2). A risk multiplier of 1 is applied in each case (HS2, 2015). Implicit within this is an assumption that condition enhancement is effectively instantaneous.

4.6 The available evidence indicates that it is reasonable to anticipate a one-step enhancement in condition. However, singular interventions will not lead to a sustained enhancement of condition (Forestry Commission, 2009; Woodland Trust, 2009). To use a simple example to illustrate the point: clearance of rhododendron can be done as a singular intervention – a bit like weeding your garden – but continued aftercare e.g. herbicide-wiping, new growth removal, is required to sustain the condition improvement.

4.7 On this basis, it is reasonable to consider that biodiversity unit credits gained through enhancement need to equate to a sustained condition improvement on the ground. Good practice indicates that in order to achieve this there is a need for long term restoration plans on a site by site basis informed by detailed

biological survey which, in turn, informs restoration targets. There is also a need for target monitoring against delivery.

4.8 Does enhanced condition happen quickly? Is it reasonable to assume it is without risk and not allow for discounting time to target condition? Techniques for the management and enhancement of woodland, such as seeding ground flora, are well established. Thus, it is reasonable for HS2 Ltd to assume that enhancement is effectively at minimal or no risk. However, it is unclear if the metric only included the uplift (change) in condition in the calculation.

Conclusions

4.9 Chapter 3 recommends that irreplaceable habitats, including ancient woodland, are taken out of the HS2 NNL metric, and a separate report focused on irreplaceable habitat mitigation and compensation should be produced. Enhancement is a good option and should feature in such a report.

4.10 Overall, the evidence leads us to conclude that enhancement of ancient woodland is a good lower risk option consistent with good practice, but HS2 Ltd need to provide certainty on the sustainable management and monitoring of condition targets.

Recommendation

4.11 It is recommended that ancient woodland is excluded from the HS2 NNL metric and that enhancement is accounted for in a separate report, with HS2 Ltd providing certainty on sustainable management and monitoring of condition targets.

5: Position in the Ecological Network

5.1 The HS2 metric includes a multiplier that places a value on the position of a habitat that is being lost or gained in the wider ecological network. HS2 Ltd explain that this adaptation from the Defra metric incorporates principles set out in the Lawton Review (2010) for biodiversity restoration by creating more, bigger, better and joined habitats (HS2, 2016). This is an adaptation of the Defra metric that substitutes the Defra 'spatial risk' multiplier, explained below, with a new 'position in ecological network' multiplier of HS2 Ltd' s own design. This new multiplier scores both lost and gained habitats on the basis of their 'position in the ecological network' as determined by their connection with other habitat, attributing higher scores to habitats considered to be more connected. The criteria used to score this are explained in HS2, 2015 Appendix A. In summary the multiplier gives weight to those habitats in a block of 1ha or more which have physical connectivity to other habitats with a gap of no more than 15m. In considering this adaption to the Defra metric, which is both an addition of a new multiplier and the removal of a Defra metric multiplier, the Review question is as follows:

Question: **What is the ecological justification for incorporating the position in the ecological network adaptations, both in terms of the principle and in terms of the specific adaptations made and the criteria being applied?**

Defra metric spatial element

5.2 The Defra metric has a spatial element incorporated with the inclusion of a multiplier that reflects the geographical location of the habitat being created in relation to that lost. An additional multiplier specifically for habitats being created, with scoring based on the geographical location of the offset provision, is referred to as the 'spatial risk' multiplier in the Defra metric. By including this multiplier, the number of biodiversity units to be created increases the further away the created habitat is from that being lost. In practice this acts as an incentive to encourage local offsetting provision, as offsetting at a greater distance requires more biodiversity units to be provided. This aspect of the Defra metric has particular relevance to local spatial planning and development management. It seeks to embed a biodiversity offsetting approach through local biodiversity strategies and objectives, encouraging local planning authorities to develop 'local offsetting strategies' to fit with existing initiatives or to trigger such consideration where initiatives are absent (Defra, 2012). Offsetting provision is therefore informed by, and contributes to, the local priorities and objectives for biodiversity., Offsetting that is provided outwith such local objectives is therefore expected to provide more biodiversity units to make up for the lack of join up with local biodiversity planning.

HS2 metric network element

5.3 The HS2 metric does not account for any geographical relationship between losses and gains, but assumes that habitat in large blocks with gaps of no more

than 15m is more beneficial to biodiversity than smaller blocks that are over 15m from each other, placing value on the size of habitat compensation blocks.

5.4 HS2 Ltd supports this approach by using an example of a 1ha block of woodland with connectivity to adjacent habitat blocks being of higher value, in terms of connectivity to the wider ecological network, than small and isolated fragments of woodland totalling the same 1ha area (HS2, 2016). HS2 Ltd considers a habitat to be isolated if the next available habitat is over 15m away.

5.5 The HS2 metric criteria and scores are shown in table 5.1 below. This section of the Review discusses these criteria, including the use of 15m and the lack of accounting for the influence of the HS2 line itself in reducing connectivity. But firstly it considers the 'position in ecological network' definition, as the definition itself does not feature in the Defra metric.

Table 5.1: HS2's 'position in ecological network' multipliers are explained in: Consideration of position within ecological network prior to development: from HS2, 2015 Appendix A

Importance within existing ecological network	Multiplier
• Habitat areas which form part of a contiguous area of habitat(s) of principal importance which is of more than 1ha in size (core habitat block) and have connectivity with other areas of semi-natural habitat	3
• Habitat areas which form part of a contiguous area of habitat(s) of principal importance which is of more than 1ha in size but have little or no connectivity with other areas of semi-natural habitat (i.e. those that do not fall under score of 3 above); • Habitat areas which form part of a contiguous area of habitat(s) of principal importance which is of between 0.25ha and 1ha in size (regardless of connectivity – these are considered as 'stepping stones') • Habitat which forms part of an area of semi-natural habitat which provides continuous physical connectivity between existing 'core habitat blocks'.	2
• Any other areas which do not meet the criteria identified for either a multiplier of 2 or 3 above.	1

Defining position in ecological network

5.6 The terms 'position in the ecological network' and 'connectivity' are used interchangeably within the HS2 documents, and this was also found to be the case in the discussions at the workshop events. These concepts have been explored in greater detail, and scientific evidence sought to underpin definitions.

5.7 The position of a habitat within a wider ecological network is understood to have a bearing on the biodiversity value of that habitat, as described and referenced below. A well-connected habitat provides greater ecological value in terms of: species dispersal to strengthen the gene pool; the ecological functioning of connected meta populations; species movement to fulfil seasonal changes in habitat use (which can be local, regional or international); improved opportunities to respond to external factors; and the daily movement of species for feeding, breeding, resting and social interactions. This well established understanding of the importance of species movement underpins the '*Making Space for Nature'* Review of wildlife sites in England and the connections between them (Lawton *et al.,* 2010). Conversely, the Lawton Review identifies that a poorly connected habitat can have negative implications for ecological functioning if these basic elements are impeded. This Review has sought a number of key references to give a more in depth understanding of the available evidence that underpins the Lawton Review (2010), particularly in light of the linkages HS2 Ltd has made to

the Lawton Review in explaining the inclusion of the position in the ecological network multiplier (HS2, 2013; HS2, 2016).

5.8 An ecological network, is the full set of sites that collectively support sufficiently large and robust populations of species, that enhance their resilience to environmental shocks, such as extreme weather events, and which enable movement at various scales, from the daily and seasonal movement amongst different habitat patches, to gene flow between nearby subpopulations, to longer distance seasonal migration, dispersal and potential range shifts under climate change. Such networks should also support the underlying natural processes that are necessary to keep the ecosystem working and provide habitat for its constituent species (Bennett and Wit, 2001; Jongman and Pungetti, 2004; Bennett and Mulongoy, 2006; Lawton *et al.*, 2010).

5.9 An ecological network will have different attributes, such as: patch size; longevity and seasonality of connections; proximity of patches to each other; how much total area they cover; and what land cover is in the 'matrix' between them (Humphrey *et al.*, 2014; Macgregor *et al.*, 2014). The relative importance of these different attributes varies among species (Humphrey *et al.*, 2014). Core patches of habitat are a critical component of networks and a key consideration before thinking about movement between them, though the size of required 'core patches' varies greatly across species.

5.10 Connectivity refers to how well a landscape supports movement (usually of species, but the concept is also applied to ecological processes such as flows of water (Taylor *et al.*, 1993; Lindenmayer *et al.*,2008), and is therefore one attribute of an ecological network. Connectivity is species-specific because species have varying habitat requirements and abilities to disperse and cross gaps, and it is therefore difficult to ascribe a connectivity value without specifying what that connectivity is for.

5.11 The HS2 metric assumes that physical connections in the landscape represent a good proxy for actual movement of species. However, species habitat requirements are often much more subtle than simply having 'woodland' or 'grassland' as it appears to humans (Lindenmayer & Fischer, 2007; Lindenmayer *et al.*, 2008), and so physical proximity of patches of vegetation, without consideration of the internal characteristics of those patches, can over-estimate species' ability to live in and move through them. Furthermore, individuals of different species are often quite capable of crossing gaps between suitable habitat patches, even over an apparently hostile intervening matrix between habitat patches. This is most obvious for birds and bats, but also applies to a wide-range of other groups too. For example, even dormice are quite capable of crossing open fields to disperse and don't need hedgerows to do so (Büchner, 2008).

5.12 Consideration of the evidence around the relative importance of different ecological network attributes indicates that patch characteristics (Lawton's 'better' principle) is of high importance for all species groups, and an essential foundation for the others (Skirvin *et al.*, 2013; Humphrey *et al.*, 2014). So quality of natural areas created, not just size, is a crucial issue.

Use of a 15m gap and habitat patch size

5.13 The HS2 metric uses a gap of 15m to draw a distinction between connected and unconnected habitat. Where there is a gap of 15m or more, the habitat is considered to be unconnected for metric scoring purposes. The HS2 metric does not appear to provide any rationale for the use of 15m as opposed to any other distance. Evidence indicates that this short distance is not necessarily a barrier to connectivity as most (though not necessarily all) terrestrial species should be able to cross a gap of that size fairly readily (Eycott *et al.*, 2012). However, this will also be dependent on what was in the 15m gap and factors such as physical conditions (light, moisture, wind conditions etc.) are relevant, as well as the question as to whether the gap could interrupt some natural processes (e.g. hydrology, transpiration, carbon storage) (Haddad 2015). The significance of the effect on biodiversity could also depend on the size of the patches themselves, and it is recognised that gaps in between larger patches of natural land cover would probably be much less of a problem than numerous gaps between smaller patches, as the negative 'edge effects' in the small patches would be much greater. It is concluded that focusing too much on inter-patch distance risks using a very coarse measure of connectivity, at the expense of other attributes.

5.14 A lack of explanation to underpin this criterion is also compounded by the approach taken to considering the potential influence of the HS2 line itself, as described below. The line is a minimum of 22m wide (HS2, 2012), therefore over the 15m criteria, and yet the HS2 metric does not appear to account for this potential barrier to connectivity. HS2 Ltd (2016) evidence explains that the line itself is not considered a barrier due to the infrequency of trains and the ability of a number of species to cross the line. This contradicts the blanket use of 15m in the criteria for scoring connectivity of habitats, where areas of qualifying habitat separated by gaps of 22m+ of low distinctiveness habitat (such as improved grassland or bracken cover) will have been afforded a lower connectivity score - unless the low distinctiveness habitat is the railway line itself.

5.15 Whilst the full range of attributes contributing to ecological network functioning are missed, the proposed approach by HS2 Ltd logically gives greater value to larger patches. However, in considering the criteria used for size, the use of a 1ha threshold again appears to be unexplained. The benefit of habitat size will be different with differing habitat types. Evidence for woodland, for example, suggests that there is an ecological threshold around 3-5ha where biodiversity benefits increase greatly, and another around 20ha because of the greater structural complexity of these larger areas (Humphrey *et al.*, 2014). For grassland invertebrates, on the other hand, research suggests that even small patches can support diverse assemblages (Woodcock *et al.*, 2016).

Potential effect of the HS2 railway on position in ecological network

5.16 Experts raised concerns that HS2 Ltd had sought to incorporate values for position in ecological network, and yet dismissed the potential effects of the railway itself on ecological network functioning (Natural England, 2016a). In considering the metric adaptations made by HS2 Ltd this issue is of relevance in terms of the consistent application of any such adaptations. There is evidence from around the world of roads having a serious negative effect on connectivity if not well planned (Haddad, 2015). A railway would risk creating similar problems,

though perhaps not to the same extent with less continuous traffic. A 22m gap would still create 'edge' in relation to at least some ecological processes, and therefore the potential for negative edge effects. Behavioural responses to gaps in land cover are important in determining movement of some vertebrates, but there does not appear to be any specific studies into how railways or similar infrastructure might affect vertebrates' willingness to cross such gaps. There is the potential for some species, such as barn owl, to get sucked destructively into the fast-moving air around a high-speed train (Dorsey *et al.*, 2015).

5.17 In addition to the 22m gap itself, there are potential considerations relating to the edge effect of that gap. Where the 22m corridor passes through a very large natural area it is likely to be much less damaging than a rail corridor that left (or created) only small scraps of vegetation on each side. There may be some opportunity to reduce the effect of the gap through maximising both linear connectivity along the route, and opportunities to create under and overpasses that facilitate wildlife movement.

Principle of incorporating position in ecological network into a biodiversity metric

5.18 Experts agreed that the principle of quantifying this aspect of biodiversity value within a metric was a positive addition, as it could further enhance the breadth of biodiversity factors to be taken into account when trying to establish a value (Natural England, 2016a). However, concerns were raised that the addition of a score relating to a position in the wider ecological network is something that has not been fully explored before. A lack of examples within the wider literature backs up this assertion.

5.19 Experts, whilst commending the attempt to incorporate this factor, advised that such a complicated element of biodiversity value cannot be simply equated to whether a habitat is contiguous or above a certain size, and that incorporation of position in ecological network would necessitate considerable thought and wider research to establish a robust means of assessing the value (Natural England, 2016a).

5.20 The use of a connectivity indicator and least-cost network modelling approaches have already been developed by Forest Research, and have been used in the past, for example, to test alternative scenarios for new woodland planting (Watts & Handley, 2010; Watts *et al.*, 2005, 2010). In developing metric multipliers that relate to position in ecological network, a comparison with the Forest Research method would be beneficial, providing a validity check, and allowing consideration of whether existing published methods would be more appropriate.

5.21 Evidence indicates that there are ranges of factors that inform the effectiveness of ecological networks and, as such, these criteria might be considered simplistic. The HS2 metric narrowly focusses on the benefits of a habitat being immediately next to another (or within 15m). It disregards a wide range of other factors, including the ecological benefits to species with dispersal mechanisms over 15m, mobile species able to cross such a distance, the ecological benefits of habitats being in close proximity but not necessarily adjacent or the benefit of habitat mosaics for ecological functioning (Eycott *et al.*, 2012; Humphrey *et al.*, 2014).

5.22 By applying narrow criteria, the HS2 multiplier for position in the ecological network gives weight to a specific type of connectivity, and not the full breath of connections that can aid ecological functioning. The compensation to be provided by HS2 Ltd is primarily in blocks of land close to the new railway, as defined by the HS2 Phase 1 Hybrid Bill. It is apparent that created habitats will be favoured by the narrow criteria used to reward position in the ecological network, and that functioning ecological connections outside the HS2 definition will not be recognised. This approach risks a well-connected habitat that is being lost attaining a low connectivity score due to failing to meet the HS2 criteria, and therefore not being adequately compensated for in terms of equivalent biodiversity units. The narrow criteria risk overly favouring the HS2 Ltd compensation approach, and under recording loss of biodiversity value.

5.23 Experts raised concerns that the specific application of the position in the ecological network multiplier resulted in 'double counting' because of the additional weight given in the criteria to a habitat being adjacent to another of high distinctiveness. They stressed that the distinctiveness of that adjacent habitat will have already been taken into account if that adjacent habitat was being lost or gained. It was felt that this was particularly pertinent given the nature of compensation provision in large blocks (Natural England, 2016a).

5.24 Experts highlighted the way that Warwickshire County Council incorporated an element of connectivity in its offsetting scoring (Natural England, 2016a). The Warwickshire, Coventry and Solihull Local Authorities, through CSWAPO[4], were one of the Defra Pilots established in April 2012 to test the current Defra metric. The offsetting calculator currently used by Warwickshire County Council does not incorporate the Defra spatial multiplier (Martland, 2014), but its own multiplier is applied to the resulting biodiversity unit calculation if the proposed compensation site is at a different location to the development. The multiplier considers the strategic location of the compensation. However, unlike the Defra metric, Warwickshire County Council uses a landscape-scale connectivity mapping approach to identify areas of habitat that are important for the movement of species. Using this information each two-kilometre square is designated as 'Non-strategic' (multiplier = 2), 'Semi-strategic' (multiplier = 1.5), or 'Strategic' (multiplier = 1) depending on woodland cover and the relevant multiplier applied to the calculation according to the location of the compensation site (Wood, B. pers comm., 5th July 2016; Warwickshire County Council, undated a&b)[5].

5.25 As noted, the adaptation made by HS2 Ltd also includes removal of the spatial risk multiplier found in the Defra metric, as well as the addition of the position in ecological network multiplier. By removing this element from the metric, HS2 Ltd has taken away the 'incentive' to create compensation in close proximity to loss, and in accordance with any local biodiversity strategies. The HS2 metric is applied retrospectively to the compensation provision, and the scoring does not incentivise compensation delivery because it is already determined. Such an incentiviser is therefore more appropriate to a metric that is driving compensation through an offsetting approach. Coordination with local biodiversity strategies

[4] Coventry, Solihull and Warwickshire Association of Planning Officers

[5] Non-strategic cells have less than 5% woodland cover; semi-strategic have greater than 20% cover, and strategic areas are those with between 5% and 20% cover. Areas with between 5% and 20% are favoured in the metric over areas with higher percentages of woodland cover as the latter already have good connectivity and there is more ecological benefit from locating compensation where it can improve connectivity in these intermediate areas.

would add considerable complexity to such a large linear scheme, although it is understood that compensation provision has sought to be as local as is practicable to the loss. How successful HS2 Ltd has been in achieving its goal has not been confirmed because habitats lost are not readily linked to habitats gained in the publicly available NNL data we examined. See 'Appendix A - Sensitivity Analysis' for analysis of this component of the HS2 metric.

Conclusions

5.26 The aspiration to incorporate connectivity within the HS2 metric is commendable. From the available evidence, it is concluded that connectivity is an important factor in attempting to quantify biodiversity value, and it is widely understood that poor connectivity can affect ecological functioning. It is apparent that in seeking to quantify the contribution that position in ecological network can make to biodiversity value, there are a number of complex factors to consider. In light of that complexity, including a weighting factor based on 'position in the ecological network' within a metric is likely to require notable research and both expert and practitioner discussion to inform a more robust and evidence based approach. A narrow application, applying criteria that are not underpinned by such scrutiny and evidence, risks bias in scoring, by under or overplaying value. This point is further discussed in 'Appendix A - Sensitivity Analysis'. The danger of a poorly evidenced multiplier is that is can be criticised for causing a skew in the results, and the criteria used by HS2 Ltd for defining 'position in ecological network' are considered to be favourable to the nature of compensation provision being in large contiguous blocks.

Recommendations

5.27 The current means of adding a connectivity factor into the HS2 metric is overly simplistic, and, in the absence of an evidence based application, there is a risk that the multiplier adds bias by favouring a narrow set of criteria whilst other valid criteria are not incorporated. It is recommended that the 'position in an ecological network' multiplier is removed from the HS2 metric.

5.28 In recognising the constraints of the Defra spatial risk multiplier for a large scale linear scheme, it is not recommended that this multiplier is re-added.

5.29 It is recommended that Natural England coordinates the development of a new spatial multiplier that is better grounded in the growing body of scientific and expert knowledge on ecological connectivity and which would be applicable to both small developments and large infrastructure projects.

6: Target condition and scoring of hedgerows post-construction

6.1 Hedgerows are a linear feature and are treated separately by both metrics being considered. The contention that was raised relates to the lifting of the condition multiplier cap on hedgerows and that hedges are scored in post-construction calculations.

6.2 HS2 (2015a) states that:

"*2.2.12 Following initial passes at the calculation and feedback from workshop sessions, it was decided that, for hedgerows, the proposed cap* [on condition scores] *is overly precautionary. Based on feedback and experience from ecologists working on transport infrastructure projects, it is considered realistic to expect that newly created hedgerows can reliably be created to achieve both high distinctiveness (6 x weighting) and high condition (3 x weighting).*

2.2.13 Therefore, in relation to hedgerows, it is allowable to target both 'high' distinctiveness (6 x weighting) and 'high' condition (3 x weighting) within the post-construction calculation."

6.3 The primary question is therefore:

Question: Would a moderate condition weighting allow for actual condition variation and be more realistic?

6.4 HS2 Ltd treat all hedgerows as highly distinctive, irrespective of their actual quality, which is consistent with the Defra offset metric approach.

6.5 The Defra offset metric uses the Farm Environment Plan (FEP) model as the basis for assessing condition (Defra, 2013), as set out in the Higher Level Stewardship - Environmental Stewardship handbook (Natural England, 2012). Essentially this attributes a condition score from 1 to 3 based on height, width and 'gappiness' attributes. Hedgerows are quick growing and easy to establish (LWT, undated). They have been a part of the agricultural landscape for several hundred years in the United Kingdom and day-to-day management is well understood and widely practiced, as illustrated by RSPB & GCT (undated), PTES (undated), Duncan, 2010, and Mersey Forest (undated).

6.6 Based on the available evidence it is considered that HS2 Ltd should be able to deliver high condition (FEP standard) hedgerows post-construction within their prescribed 10 year time scale.

6.7 At the time of the HS2 metric development the FEP approach was the best available evidence regarding condition and its assessment. However, experts considered the FEP to be outdated and somewhat inappropriate (Natural England, 2016a) in light of advances in the understanding of hedgerow condition, such as the hedgerow appraisal system developed by Foulkes *et al.* (2013). This type of approach allows for a more sophisticated and finer grained approach to the assessment of hedgerow condition, as opposed to the course grained FEP approach. A finer grain approach to condition pre- and post-construction means

that the biodiversity value of hedges is more accurately evaluated in metric calculations. The better understanding of effective hedgerow management makes this possible.

6.8 While treating all pre-construction hedgerows as highly distinctive, irrespective of their actual quality, is consistent with the Defra metric, doing so deprives HS2 Ltd of the potential for significant uplift in biodiversity units delivered if, for example, a poor condition hedgerow (pre-construction) is replaced by an excellent condition hedgerow (post-construction). This approach is adopted by the Warwickshire Coventry and Solihull Biodiversity Impact Assessment Calculator (v18.3; Martland, 2014)) and it is recommended in the Ecological Technical Group's submission to the Review (Lowe, 2016).

Conclusions

6.9 The HS2 NNL metric approach to hedgerows is consistent with the Defra biodiversity offset metric approach, and evidence on hedgerows suggests that lifting of the condition multiplier cap is reasonable.

6.10 The use of the FEP model in the Defra offset metric as the basis for assessing condition and the allocation of a 'high distinctiveness' score to all hedgerows is overly simplistic and should be reviewed in light of improved understanding of hedgerow management and experiences of applying the metric in the Defra pilot areas.

Recommendations

6.11 It is recommended that HS2 Ltd should maintain the separate hedgerow accounting line in the NNL metric and not impose a cap on target condition.

6.12 It is recommended that HS2 Ltd assess the distinctiveness of hedgerows pre- and post-construction in line with current practice in Warwickshire.

6.13 It is recommended that Natural England coordinate the development of an updated multiplier model for hedgerow condition, in light of improved understanding of hedgerow management and experiences of applying the metric in the Defra pilot areas.

7: Time to target condition

7.1 HS2 Ltd adapted the way the Defra metric 'time to target condition' multiplier was applied to habitats. Concerns were raised about this adaptation, suggesting that the changes were not underpinned by evidence or scientific justification (Natural England, 2016a). The Review examined the question:

Question: Are the revised time to target condition scores used for habitats justified?

7.2 Defra (2012) explains the principles underlying the way in which temporal factors are dealt with. Explaining that a metric should recognise a situation where there is a mismatch between the timing of a biodiversity loss and compensation reaching the required quality or level of maturity to functionally replace that loss.

7.3 The Defra metric includes a temporal risk multiplier, which creates an increasing need for additional biodiversity units to be provided in line with the time taken for the new habitat to reach maturity, or an agreed level of ecological functioning. This is the 'years to target condition' multiplier[6]. Defra (2012) goes on to explain that the addition of such a multiplier incentivises the upfront creation of habitats prior to loss, which is often referred to as 'habitat banking.' This is clearly beneficial as there will be no time lag between losses and compensation. But in practice it can be difficult to achieve as, typically, compensation providers will want to have assurance of a return for their investment. The need for additional biodiversity units for habitats that take longer to recreate should also encourage changes in development design to avoid loss of such habitat types (Defra, 2012).

7.4 The adaptation presented in the HS2 metric is a change in the estimated time taken for habitats to reach maturity. However, it must be acknowledged that Defra (2012) only gives very broad time bands as an indication of time to reach maturity. Multiplier numbers that are used in both metrics to account for years taken to reach target condition remain the same for both metrics, rather it is the estimated number of years for each habitat type that have been modified by HS2 Ltd. The HS2 metric provides a more specific time than the Defra metric, and that more specific estimation tends to fall on the lower end of the Defra range. HS2 (2013) describes the methodology, prior to the additional HS2 Ltd modifications of 2015.

7.5 In considering other metrics where adaptations to this element of the metric have been made, the Review team looked at the guidance for the Warwickshire County Council metric, and found that rather than specify times to target condition, a developer should identify the estimated time to be taken themselves in their planning application (Martland, 2014). For small scale development projects being determined by a planning authority, this is potentially beneficial for biodiversity outcomes, as there is the opportunity to use both scientific evidence and on-site conditions to make an informed estimate.

[6] In the HS2 methodology this is referred to as 'Time to Target Condition'

Table 7.1: Comparison of the 'time to target condition' values used by HS2 Ltd to the examples cited Appendix 2 of the Defra pilot offsetting Technical Paper (Defra, 2012)

Habitat type used by HS2	HS2 years to target condition category	Defra time-scale (years)	Defra ecosystem type from Appendix 2
Open mosaic habitats on previously undeveloped ground	5	-	*no comparable habitat*
Ponds	5	1 – 5	eutrophic ponds
Grasslands	5 or 10	1 – 20 50 – 100+	eutrophic grasslands chalk grasslands
Hedgerows	5 or 10	-	*no comparable habitat*
Woodland (for landscaping)	10	-	*no comparable habitat*
Young heathland / acid grassland	15	20-100+	oligotrophic grassland
Mature heathland	32 or above	50 – 100+	heathlands
Woodland (for ecological purposes)	32 or above	500 - 2000	ancient woodland

7.6 Experts advised that the HS2 Ltd estimated times to achieve target condition for the habitat types were overly optimistic, focusing on the time it takes to establish or create habitats, rather than the time it takes for them to achieve ecological functionality (Natural England, 2016a). Experts considered that the values used for habitats did not take the scientific literature or current best practice sufficiently into account. These discussions are recorded in more detail in the workshop proceedings (Natural England, 2016a).

7.7 HS2 (2016) advised that the changes to time to target condition were based upon the guidance provided in the Defra 2012 offsetting documentation, and the professional opinion of HS2 Ltd's consultant ecologists, and assume that best practice techniques for habitat creation will be used. Principles relating to the times to target condition promoted by HS2 Ltd are set out in HS2 Information Paper E26 (HS2, 2015b). That paper sets out a commitment to agreeing an appropriate maintenance and monitoring strategy with Natural England for ecologically led habitat creation.

7.8 The term 'time to target condition' is referred to in the HS2 methodology documents (HS2, 2013; HS2, 2015a), yet the HS2 Technical Paper refers to the HS2 timings as 'period of establishment' (HS2, 2012). There is some potential confusion as to what the timings represent; whether a point at which all establishment prescriptions are complete, or a point at which the habitat is deemed to be ecologically functioning. Some discrepancies between the periods of establishment in the Technical Paper and the time to target condition in the HS2 methodologies add to this confusion. However, the Technical Paper does explain that the high level timings allocated to habitat types will be developed, updated plans will be produced during the detailed landscape design, and that HS2 Ltd intends to devise and agree the 'success criteria' with Natural England for all habitat areas to be created (HS2, 2012).

7.9 Furthermore, HS2 Ltd highlights that the target condition has been capped at moderate for accounting purposes (i.e. the metric is not calculating time for created habitat to achieve good condition, despite this being the long term

objective where possible) where the habitat type being provided post construction is a high distinctiveness habitat (HS2, 2013). This is considered to be a precautionary approach by HS2 Ltd (2016). HS2 Ltd (2016) suggests that this adds to the justification for the more optimistic timeframes for achieving target condition because the target for accounting purposes is taken to be moderate for all biodiversity units created for high distinctiveness habitats (good condition is still accounted for with medium distinctiveness habitat creation). However, the extent to which this can be considered to be precautionary is not clear from the HS2 documentation. It is not apparent: how, or if, the same targets are applied to habitat restoration; which habitat types are expected to achieve a greater than moderate condition within the project timeframe; and the proportion of compensation provision that falls into this category.

7.10 HS2 Ltd argues that the time to target condition changes should be considered in the context of the precautionary approach of only accounting for achieving moderate condition for all high distinctiveness habitats created post-construction. However, it is not possible to compare the two influences against each other, as both have the effect of reducing the number of biodiversity units required post construction; as a consequence of a lower estimated temporal risk, and a lower condition to be achieved.

7.11 Defra (2012) estimates were based on times to achieve maturity or ecological functionality for different habitats. HS2 Ltd (2016) suggests that as the Defra estimates were predominantly based on habitat restoration rather than creation, they are unduly onerous for HS2 purposes where habitats are being created not restored. This review did not identify any evidence supporting the assumption that it takes longer to restore habitats than create new habitats, and this will differ between habitat types.

7.12 Applying generic periods to target condition can be overly simplistic and assumes that soil conditions, source of seeds, transfer/establishment method, weather conditions, aftercare management, and willingness of landowners are all optimal (Jefferson, R. *pers comm*., 2014). The HS2 metric allocates a maximum time to target condition of '32 years or more' and explains that this is in accordance with the Treasury's Green Book (HS2, 2013). Experts highlighted the time taken for woodland establishment, with experts advising that the biodiversity value of the woodland scrub layer can take 30 years alone to establish (Natural England, 2016a).

7.13 The available data did not allow for a comparison of the two metrics in terms of the influence on the overall calculation that use of the more optimistic HS2 Ltd 'time to target condition' times has had.

Conclusions

7.14 In conclusion, it is apparent from HS2 Ltd evidence that time to target condition is more specific and more optimistic that the Defra temporal risk multiplier, which is difficult to use within a calculation due to its wide ranges. There is some confusion with regard to the end point to be achieved within the stated timeframes. Greater clarity on what constitutes target condition would help to determine whether allocated times are appropriate. The commitment HS2 Ltd has made to refining success criteria with Natural England is important, and this should be an evidence based exercise.

7.15 Professional opinion is not explained or justified within the HS2 documentation, and there is a lack of evidence to support the assumption that habitat restoration (which informed the Defra times to target condition) generally takes longer than new habitat creation. Additionally, the claim of a precautionary approach by capping achieved habitat condition at moderate for high distinctiveness habitats is not quantified to enable a better understanding of the level of precaution that can be assumed.

7.16 The sensitivity analysis undertaken for the Review, as documented in Appendix A - Sensitivity Analysis, was unable to identify the data necessary to determine whether the more optimistic HS2 times to target condition had a notable effect on the overall calculation.

7.17 There is an absence of an agreed approach to this aspect of biodiversity metrics, and the Warwickshire County Council example of metric application relies on case by case considerations (Martland, 2014).

Recommendations

7.18 The HS2 metric is more optimistic that the Defra metric. It is recommended that the professional expertise of the consultant ecologists should be backed up by published evidence to justify time to target conditions. It is likely that such understanding will include case study experience, and that should be included in justifications given.

7.19 The time to target condition in the Defra metric cannot be applied in a metric calculation. It is recommended that an independent group develop a set of values to use for different habitats being created, restored, or enhanced that could add to the existing guidance on biodiversity metrics. Natural England would be willing to coordinate this group.

7.20 Given the assertion that best practice methodologies will be applied to all habitat creation (HS2, 2016), and the explanation of the precautionary approach to target condition, it is recommended that an indication of which habitat types are expected to achieve a good condition weighting within the project period is placed in the public domain.

8: Temporary land use

8.1 As described by HS2 Ltd in their submitted evidence (HS2, 2016), the HS2 metric calculation assumes that all land covered by the scheme will be permanently lost. In reality, some of the land will only be used during the construction period, and these areas of temporary land use can then be reinstated post-construction. Where such habitat types are of medium or high distinctiveness, the temporal risk multiplier has been applied. The time lag relating to the estimated time taken for the habitat to be reinstated is therefore accounted for within the HS2 NNL metric for these habitat types. For habitats of low distinctiveness, defined as: arable fields; improved grassland; buildings; spoil heaps; bare ground; and amenity grassland, the temporal risk multiplier has effectively been excluded by HS2 Ltd from the calculation (as a multiplier of 1 has been added to both pre- and post-construction calculations, thereby negating the influence of this multiplier). This means that the calculation takes no account of any time lag to reinstate these habitats. There appears to be a discrepancy between the various HS2 documents over what habitat types are classified as being of low distinctiveness and being allocated a multiplier of 1. The HS2 Ltd evidence submission (HS2, 2016) specifically indicates that arable field margins are not included, but the HS2 methods paper (HS2, 2013) refers to arable field margins in the discussion on low distinctiveness habitats at 3.2.4, whilst the HS2 methods paper (HS2, 2015) does not refer to arable field margins.

8.2 The primary questions that the Review examined were:

Question: Is the approach to temporary land use in the calculation justified?

Question: Is a time to target condition multiplier of 1 (0 years) for low distinctiveness habitats justified?

8.3 An additional issue is that the nature of the HS2 Project is such that the construction phase will be a considerable number of years, and estimations of time to target condition appear to only relate to the time taken once habitat creation or recreation has commenced post-construction. For the HS2 project, a habitat may be lost for a number of years before any work to compensate for that loss is even started. The Defra metric does not explicitly identify this as an issue, but its purpose was for application by local planning authorities, where approved development will normally not require such extensive construction timescales.

8.4 A secondary question is therefore:

Question: Should the period that habitats are 'lost' during construction be taken into account in choosing the time to target condition multiplier?

Approach for low distinctiveness habitats taken for temporary land use

8.5 HS2 Ltd advises that the approach taken reflects the low biodiversity value of the low distinctiveness habitats being lost temporarily during construction, and that when a five year time to target condition was initially applied, HS2 Ltd concluded that this led to a 'disproportionate effect' and was therefore removed (HS2, 2016). There does not appear to be any ecological justification to support this adaptation.

8.6 The available data does not identify which habitat polygons will be temporarily lost, and which are permanent losses. From the information available, it is not possible to determine the relative amounts of low, medium and high distinctiveness habitats that are deemed to be temporarily lost, although HS2 Ltd did confirm that high distinctiveness habitats are not affected by the temporary losses (Collins, D. *pers comm*., June 2016). The sensitivity analysis at Appendix A considers the potential effect on the calculation when a five year time to target condition multiplier is added back in.

8.7 Experts did not provide significant evidence to support their concerns in relation to this adaptation in the HS2 metric. Rather, they stressed that it was a matter of principle that a biodiversity metric (whether for accounting or offsetting purposes) gave value scores to all habitats being lost, and that metrics are inherently built to be proportionate in the scores they allocate (Natural England, 2016a).

8.8 HS2 Ltd asserts that given the considerable habitat within the scheme area there will in fact be areas available as habitat at any given time (i.e. not all habitats will be taken at the same time during construction) and thus the lack of scoring is at least partly redressed. The comparison of the two influences is impossible to calculate without detailed information on what habitats will be used, when and for how long.

Accounting for construction time

8.9 The extent of the scheme is such that construction time is extensive in comparison to smaller scale projects, yet the temporal multipliers only reflect the time lag for recreation or creation, not the time in between habitat loss and the commencement of restoration. This is a time lag that is not specifically factored in to the Defra metric over and above the time to reach condition multiplier. For HS2 this time lag could be a number of years before creation/recreation begins to be attempted.

8.10 Temporary land use for construction over a number of years may also affect time to target condition because factors such as soil compaction, importation of foreign materials, and contamination risk will all be greater over a longer time period, which may take additional time to rectify.

Conclusions

8.11 The 'disproportionate effect' of the low distinctiveness habitats to be temporarily utilised during construction is not as a result of the disproportionate nature of time to target condition scores being applied. HS2 Ltd has already adapted the

time to target condition aspect of the metric and so it is assumed that for all other purposes the scores are supported. Rather it appears to be the case that the large volume of low distinctiveness habitat being taken for temporary use (which is to be expected from a scheme of this scale and nature) is the driving factor for the resultant influence on the scores. It is also recognised, however, that for some low distinctiveness habitats such as bare ground, adding in a five year time to target condition would be an over application as such habitat does not take substantial time to recreate.

8.12 In conclusion, the removal of scoring for low distinctiveness habitats in temporary use does not accord with the principles of applying a biodiversity metric whereby proportionate scores are applied to all biodiversity losses and gains. There is no ecological basis for this adaptation. To remove an element of the scoring because the result is not favourable is not an acceptable application of a biodiversity metric, and clearly would set a precedent for future metric adaptations in response to undesirable outputs. The fact that some habitats will provide a habitat function during construction does not adequately address the removal of scoring, and furthermore fails to recognise the extensive construction phase in comparison to most development to which a metric might be applied.

8.13 A lack of consideration of the extensive construction time of the HS2 project fails to account for biodiversity loss that may be more significant than for a typical development project of a smaller scale. There is the possibility that biodiversity losses are not being accounted for in the HS2 metric.

Recommendations

8.14 It is recommended that the scoring of low distinctiveness habitats taken for temporary use should be added back into the calculation, in order to fully record the biodiversity losses and gains, irrespective of whether a biodiversity metric is being used as an offsetting or accounting tool. For HS2 purposes, the 'account' has currently failed to record all losses by removing this aspect of the scoring. In recognition of the fact that some low distinctiveness habitats will not take five years to create, whilst others will do so, 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.

8.15 It is recommended that options to incorporate construction timescales are explored to determine how its impact on temporary land use can be accounted for within the metric.

8.16 It is recommended that more information is provided on the construction phase and temporary land use, with regard to: the relative proportions of habitat types being classified as temporarily lost; confirmation that habitats temporarily lost will be replaced on a like for like basis; and greater clarity on construction timescales.

9: Understanding the HS2 NNL metric

9.1 From the petitions made to the House of Commons Select Committee[7] and from the opinions voiced at the review workshop events (Natural England, 2016, 2016a) it is evident that there are concerns regarding the level of information explaining the metric and its application. For this reason, the Review incorporated the following cross-cutting question, which relates to the experience of reading and following the HS2 NNL metric documentation:

Question: Is HS2 Ltd's reporting of NNL sufficiently clear, detailed and accessible to generate confidence in the results?

Experiences of stakeholders

9.2 Table 9.1 summarises the key feedback received under three emergent theme headings: clarity of methodology; transparency of reporting, and clarity of the metric purpose and no net loss objective. A more complete record of feedback is provided in Natural England 2016 and 2016a.

9.3 Stakeholder engagement has not been incorporated into the design or calculation processes for the HS2 metric. Engagement with stakeholders is a recognised principle for biodiversity metrics (BBOP, 2012), and there are a number of examples of best practice (e.g. Network Rail) in relation to external stakeholder involvement that HS2 Ltd could draw upon.

Experiences of the Review Team

9.4 The Review Team examined the methodology and attempted to repeat some of the metric calculations to better understand and to evaluate the significance of the issues raised.

9.5 The HS2 methodology (HS2, 2013 & HS2, 2015a) includes a brief explanation of the role of a NNL calculation, but this fails to set out what HS2 Ltd understands to be NNL. Furthermore, the methodology explains the use of biodiversity metrics in terms of offsetting purposes, which confuses the distinction between using a metric as an accounting tool (which is what HS2 Ltd has done) and an offsetting tool (which is what the Defra metric was designed for). This Review has explored the definition of the term 'no net loss' at Chapter 3, and has sought to explain the differences between the use of a biodiversity metric for offsetting or accounting purposes, noting that the latter is previously untested. A clearer explanation of the concept of NNL and the distinction between use of metrics for offsetting and for accounting is needed to improve understanding of what HS2 Ltd has attempted to achieve through this exercise.

[7] See the petitions received by the High Speed Rail (London - West Midlands) Bill Select Committee (Commons) at: http://www.publications.parliament.uk/pa/cmhs2/petitions/petcontents.htm

Table 9.1: Workshop feedback summarised by theme

Theme: Clarity of methodology
• Difficulties in accessing underlying data means that methodologies cannot be repeated and tested. • Adaptations are not ecologically justified within documentation; rather professional judgement is referred to, without rationale. • Where aspects of the Defra metric have not been adapted but rather have been retained, there is equally a lack of ecological justification that this remains the most suitable approach. • There is a lack of information on any internal or external quality assurance processes. • The significance of adaptations are not clearly stated, and explanation for adaptations make reference to elements of the scoring that 'address' any imbalance, without quantification of the relative influences. • Despite the expertise of the Review Team and workshop attendees, there was still a need for HS2 Ltd to explain a number of adaptations in greater detail. • It is apparent that the 'retrospective fit' of the metric for accounting purposes has caused difficulties and consequential adaptations that are not necessarily ecologically informed.
Theme: Transparency of reporting
• Reporting on habitat types is difficult to follow between pre and post construction calculations, and this is particularly pertinent for woodland. • Workshop attendees voiced concerns over ancient woodland calculation errors in particular, which are not within scope of this Review, but this links to the general concern that it is not possible to follow individual polygons of habitats lost through to their compensation. • A lack of granularity on pre and post construction figures. • Lack of detail in relation to the use of the Farm Environment Plan (FEP) approach for habitat condition scoring. • A number of workshop attendees advised that there are mismatches between information within the Environmental Statement, engineering specifications, landscape specifications and the HS2 metric.
Theme: Clarity of the metric purpose and no net loss objective
• There is insufficient explanation of what HS2 Ltd understand the term 'no net loss' to mean and how it has been interpreted in order to present the objective of applying the HS2 metric. • There is insufficient consideration given to the limitations of a metric in accounting for all aspects of biodiversity value, and a lack of explanation as to how this will be rectified as the HS2 project progresses and further ecological work progressed. Indirect effects are an example of this. • There is a lack of recognition of the issues caused by using a metric for accounting purposes, e.g. where established biodiversity offsetting rules are broken in the compensation provision, but then have to be accounted for within the metric. • It is apparent from the petitions made to Select Committee and the workshop events that there is confusion stemming from the use of the metric as an accounting tool rather than and offsetting tool.

9.6 There is a lack of explanation of the quality assurance process used by HS2 Ltd in developing its metric within the published methodologies (HS2, 2013 & HS2, 2015a). More detail and the inclusion of external quality assurance may have improved transparency and confidence in the application of the metric. Whilst both Natural England and Defra did provide early feedback on some of the specific adaptations (HS2, 2015a) that are described in the 2013 methodology (HS2, 2013), it is only as a result of this review that the final HS2 metric has been externally scrutinised in detail and as a complete final metric.

9.7 There is no sensitivity analysis provided alongside the published methodologies and results to explain how adaptations to the Defra metric affect the NNL calculation. In the absence of this information the Review Team, and some stakeholders, have attempted to replicate aspects of the HS2 calculation and to undertake sensitivity analyses of their own. The experience of the Review Team was that this is not a straightforward exercise and aspects of the methodology are insufficiently clear to know how data was treated in the calculation. The Review Team's analyses are summarised in Appendix A of this report.

9.8 While the application of the HS2 metric is inevitably complicated by the scale of the scheme, it should not prevent replication of the results, and there is a reasonable expectation that there should be sufficient published information to understand the consequences of adaptations of the original Defra methodology.

Iterative metric calculations in light of refinements and new information

9.9 HS2 Ltd has undertaken a full calculation to account for biodiversity losses and gains by using the HS2 NNL metric, and the results of this calculation are presented in the most recent HS2 methodology document at table 3 (HS2, 2015a). This represents a snapshot in time, based on the information HS2 Ltd had available in relation to habitats present and potential impacts of the scheme. Additional ecological information will continue to be gathered as the required legislation passes through Parliament and further access to land for survey purposes is gained. Given the considerable construction timescale, there is also the potential for further refinement of understanding and compensation provision as assumptions are tested on the ground. It is considered imperative that in order to truly meet the requirement to seek to secure NNL, iterative metric calculations are undertaken over time. This should commence with an initial re-consideration in light of the recommendations of this review, and then continue at appropriate points during the HS2 Project design and implementation.

Conclusions

9.10 HS2 Ltd has made its NNL calculation methodology, results (HS2, 2015a) and its data (see Appendix A) publicly accessible. This openness is commended by the Review, but is expected for a scheme receiving high levels of public funding. It is not surprising that a project of this scale and importance is the subject of such a high degree of public interest, and has generated concerns about transparency.

9.11 Based on the available evidence, it is concluded that there are justifiable grounds for some of these concerns, despite HS2 Ltd's efforts to explain its approach to the NNL calculation. This Review concludes that there is scope for improved

explanation of the methodologies used, in the reporting of calculations made, and in terms of the relationship between the use of the HS2 metric as an accounting tool and the process of evaluating compensation requirements. It is also concluded that there was insufficient stakeholder engagement and external quality assurance and this is likely to have exacerbated concerns.

9.12 Previous sections of this report have examined specific adaptations between the Defra and HS2 metrics, and issues relating to clarity or transparency can be found in most of those topic sections. Attempts to repeat some elements of the calculations have been made within this Review, and the difficulties in attempting to repeat calculations are explained in Appendix A - Sensitivity Analysis.

9.13 The use of the HS2 NNL metric cannot provide a true representation of NNL if only undertaken as a snapshot in time part way through scheme design.

Recommendations

9.14 It is recommended that there is greater 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.

9.15 It is recommended that the NNL methodology is more clearly explained so that it can be 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.

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

9.18 It is recommended 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.

9.17 It is recommended that independent quality assurance is built into the future development of the HS2 NNL metric. Examples of stakeholder engagement in the design and application of biodiversity metrics should be considered. This would provide additional expertise, aid transparency and ‘buy in’ as well as being a source of evidence to refine and justify methodologies.

10. Biodiversity opportunities

Introduction

10.1 The preceding chapters of this report have considered the adaptations made by HS2 Ltd to the Defra biodiversity offsetting metric and the application of those adaptations in the HS2 NNL metric when used as an accounting tool. The principle of adapting a metric to suit specific circumstances is widely considered to be acceptable where such adaptations are fully justified.

> "*There is no single best metric or best-practice approach, and they need to be chosen according to their purpose, with reference to good practice principles that metrics should endeavour to incorporate*."
>
> (cited in DG Environment, 2014)

10.2 The review chapters of this report acknowledge and support this principle, and therefore focus on specifically assessing the validity of the adaptions made. In reviewing those metric adaptations, additional issues and opportunities have emerged that, whilst not directly related to a comparison between the two metrics, are clearly linked to the overall purpose of securing NNL.

10.3 HS2 Ltd has made a significant effort to achieve NNL, but the nature and scale of the project is such that Natural England considers it should also be an exemplar of biodiversity conservation being delivered through growth. Here we advise on the emerging opportunities that could make HS2 an exemplar project, enabling it to go further in fully adhering to UK biodiversity policy, contributing to UK biodiversity targets, and demonstrating good practice.

10.4 Using an accounting tool to demonstrate whether biodiversity compensation is balanced is an approach to seeking to demonstrate NNL. But the commitment to NNL can, and should, be much wider than simply using particular criteria to balance the books. The design and use of a biodiversity metric is purposefully simple, with benefits in consistency, transparency and understanding. It can never fully account for all aspects of biodiversity value and should never be used alone in the absence of applying ecological expertise and site specific considerations to ensure that ecosystems are not diminished.

10.5 As discussed in the review chapters, in response to the EU Biodiversity Strategy objective of halting the loss of biodiversity and degradation of ecosystem services in the EU, and restoring them in so far as feasible (EU, 2011), the UK has similarly committed to halting the decline in biodiversity by 2020 (Defra, 2011). This is an incredibly challenging but necessary target, that is reliant upon the concerted efforts of all sectors (government, business, developers, land managers, statutory bodies, third sector, etc.) in order to be achieved. Large scale development projects will need to do more than the bare minimum and instead they should set exemplar standards for others to follow. HS2 offers a unique and powerful opportunity to demonstrate leadership and to leave a legacy of biodiversity conservation that is notably better than it would have been without the scheme.

10.6 This chapter provides recommendations focussing on the wider opportunities that have emerged from the review, for improving the approach to NNL and demonstrating good practice.

10.7 The four key opportunity areas are:

- To have greater ambition in compensating for the loss of ancient woodland
- To remove the constraints of the Bill area for the delivery of biodiversity compensation
- To apply the HS2 metric as an offsetting tool in Phase 2
- To set a new objective for delivering net gain in Phase 2

Compensation ratios for ancient woodland losses

10.8 HS2 Ltd does not use a generic compensation ratio to calculate the level of compensation required for ancient woodland losses, but designs specific measures to address the impacts at each site (HS2, 2016a). HS2 Ltd proposes to use a combination of woodland creation, soil translocation, and woodland restoration (or enhancement). Natural England confirmed that this approach is consistent with the principles in its standing advice, stating publicly in February 2016:

"Ancient woodland is irreplaceable, but where loss of ancient woodland is unavoidable, Natural England's standing advice sets out measures which might be taken including planting new native woodland or restoring or managing other ancient woodland. There is therefore no set ratio for woodland compensation and each case will be different. HS2's approach is consistent with the principles in the standing advice."

Cited in Salvidge (2016)

10.9 The Woodland Trust challenged HS2's approach to compensating ancient woodland and called for 30ha of woodland planting for each hectare of ancient woodland lost (Salvidge, 2016; Woodland Trust, 2016)[8].

10.10 What a 30:1 ratio would mean for the scale of compensation required for HS2 Phase 1 was examined by comparing this ratio with the ratio that the current proposals are expected to deliver, based on the information provided by HS2 Ltd (HS2, 2016d) and also by calculating ratios using the Defra offsetting metric (Defra, 2012a) and the HS2 NNL metric (HS2, 2015a).

[8] The Woodland Trust has claimed publicly that Natural England suggested to HS2 Ltd that 24 hectares of woodland planting should be made for each hectare of ancient woodland lost (Salvidge, 2016, Woodland Trust, 2016). This is incorrect, and Natural England has given no such formal advice to HS2 Ltd. In its formal advice Natural England advised that the ratio of compensatory habitat for ancient woodland losses needs to be discussed and should reflect the distinctiveness of this habitat type and recognise that ancient woodland is an irreplaceable habitat (Natural England, 2014).

Results

10.11 The overall ratio for ancient woodland losses reported by HS2 Ltd represents 5.25ha of woodland compensation for each hectare of ancient woodland lost; a ratio of 5.25:1 by area[9].

Table 10.1: Compensation ratios for ancient woodland and woodland losses

Scenarios	Metric multipliers [a]				Results	
	Distinctiveness	Condition	Difficulty of recreation	Time to Target Condition	Biodiversity Units per ha	Ratio [b]
HS2 metric						
Ancient woodland	8 (very high)	3 (high)	-	-	24.0	-
New created woodland						
Using typical HS2 values	6 (high)	2 [c] (moderate)	0.67 (medium)	0.33 (> 32 years)	2.65	1 : 9
Worst case assumptions	6 (high)	2 [c] (moderate)	0.1 (very high)	0.33 (> 32 years)	0.40	1 : 60
Defra metric						
Other woodland [d]	6 (high)	3 (high)	-	-	18.0	-
New created woodland						
Worst case assumptions	6 (high)	3 (high)	0.1 (very high)	0.33 (> 32 years)	0.59	1 : 30

Key

[a]: The spatial risk multipliers used by the Defra and HS2 metrics (in the latter it is referred to as 'Ecological Place in Network' multiplier) have been excluded from this analysis, so the ratio only reflects the quality of the habitat and the challenges of recreating or restoring.

[b]: A biodiversity unit based ratio differs from a simple area based ratio because the units attributed to a habitat are affected by not only its area, but also its quality (e.g. condition and distinctiveness), it spatial location and, in the case of newly created habitats, the difficulties associated with recreation or restoration. This means that there is no fixed relationship between area and units. For example, one hectare of good habitat will have a greater biodiversity unit value than one hectare of poor habitat, and will thus require more compensation.

[c]: HS2 have set a cap that limits target condition to 2 (moderate) for newly created woodland.

[d] Ancient woodland is not included in the Defra offsetting metric, so these values refer to other woodland.

[9] An analysis of the Ancient Woodland Strategy reports for Phase 1 (HS2, 2016a,b&c) has highlighted a need for further clarification by HS2 Ltd regarding the allocation of the compensation areas used to calculate the ratio estimate reported (HS2, 2016d). In particular, it is unclear whether compensation used for the calculation is exclusively associated with ancient woodland losses or also relates to other losses resulting from the scheme. If the latter is true, then the reported ratio overestimates the level of actual compensation.

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,

an area based ratio of 30:1 is appropriate. If that is legally impracticable to implement for Phase 1, it should be implemented for Phase 2.

Delivering biodiversity compensation outside the Bill area

10.18 In the HS2 Ltd report of their NNL calculation (HS2, 2015a) it is apparent that a net loss in the number of biodiversity units remains following construction, despite compensation. The calculation currently shows a 3% loss for area-based units and a 21% loss for hedgerows as a linear-based unit. These figures are regarded as provisional and subject to further revision.

10.19 Given the constraints of the Bill area, it seems probable that in order to rectify the current deficit, HS2 Ltd would need a mechanism that is out with the Bill area to deliver compensation to 'top up' the number of post-construction biodiversity units.

10.20 At the stakeholder workshops for the Review it was apparent that there is strong support for an approach that allows for compensation to be provided through voluntary arrangements that extend beyond the immediate route corridor (Natural England, 2016, 2016a). Whilst there is no scope to extend the area of compensation land formally encompassed by the scheme, moving away from the constraints of the Bill area would open up options to pursue a goal of exceeding NNL and potentially deliver additional gains, which better reflects biodiversity off-setting principles in accordance with the Business and Biodiversity Offsets Programme (BBOP, 2012; see Figure 2.1), which is widely acknowledged for setting standards internationally.

10.21 Possible approaches include direct negotiation and agreements with interested landowners or the more formal use of offsetting providers, either through existing schemes such as that established in Warwickshire or a bespoke approach for HS2. The provision in Clause 50 of the HS2 Bill which provides for environmental covenants might be used to support such an approach.

10.22 By widening the 'area of search' for compensatory habitat and engaging with a wider pool of interested landowners, greater benefits in terms of environmental and socio-economic outcomes could also be delivered. This might include, for example, looking at ecosystem services and derived benefits such as improvements to water quality, and linking with local stakeholder initiatives such as Nature Improvement Areas.

10.23 HS2 Ltd may wish to identify the remaining deficit in biodiversity compensation as a pilot project to test options that might be more extensively applied for Phase 2. Stakeholder engagement, local landowner engagement, adding to existing local biodiversity initiatives and testing a wider ecosystem services approach to integrate with biodiversity compensation could all be undertaken. There may also be potential opportunities to test approaches such as 'out of kind' benefits for non-critical biodiversity losses, which are those that might provide a benefit for biodiversity, but do not replace the ecological function of the loss. An example would be the provision of funding for a biodiversity project that is identified as a priority for a local area.

10.24 It is concluded that the deficit in biodiversity units, both in terms of habitat area and linear features now presents a positive opportunity for relatively small scale

testing of options that could be invaluable for informing the scheme wide approach to biodiversity compensation for Phase 2.

Recommendation

10.25 It is recommended that HS2 Ltd augment delivery of compensation outside the 'Bill area.' This should explore what opportunities such arrangements might offer for realising additional benefits as a result of HS2.

Applying the HS2 metric as an offsetting tool for Phase 2

10.26 As recognised in earlier chapters, there is an absence of any evidence of applying a biodiversity metric as an accounting tool as distinct to an offsetting tool, either in the UK or internationally. The HS2 Ltd approach of retrospectively accounting for pre-determined compensation is therefore considered to be a novel means of seeking to demonstrate NNL. Applying the HS2 NNL metric retrospectively leads to a number of issues.

10.27 Firstly, the use of a tool that was designed to inform compensation will inevitably lead to problems when the compensation being accounted for does not conform to the principles of biodiversity metrics.

10.28 The HS2 NNL metric includes adaptations that have not been used elsewhere. As discussed earlier, the addition of non-tradable habitats (irreplaceable habitats and protected areas) is at odds with the fundamental principle of assigning a biodiversity value through a metric to enable trading. The inclusion of non-tradable habitats in a metric creates a perception of tradability that does not conform to the strict application of the principle of case specific and like-for-like compensation for irreplaceable habitats and protected areas. This risks setting a precedent that others may use to justify similar trading of non-tradable habitats, which should only be considered on a bespoke basis and in accordance with the NPPF.

10.29 A number of other non-conformity issues arise that create difficulties in accounting, for example where habitats created for compensation do not adhere to the rule of 'trading up' where like-for-like habitats could not be created (i.e. a habitat of greater value is created): a principle embedded in both the Defra metric (Defra, 2012) and international guidance (BBOP, 2012). In retrospectively applying the HS2 NNL metric, it transpires that some compensation provision is 'traded down' potentially posing difficulties in accounting.

10.30 Secondly, using the metric for retrospective accounting, rather than to inform compensation provision, risks it being assumed that once the account balances the outcome is achieved and opportunities to go further may not be taken. Best practice approaches elsewhere make use of a biodiversity metric to drive and challenge biodiversity compensation provision to be better than historic piecemeal approaches. Both Network Rail and Highways England are currently engaging with Natural England to develop and embed this way of thinking within their business.

10.31 A further benefit of using a metric to inform compensation is the transparency that use of a biodiversity metric brings through the publication of a logical progression through a metric to identify and provide for compensation needs. As noted in the previous chapter, HS2 Ltd's documentation is very difficult to follow,

and much of the transparency issue stems from the inability to read across from the numerous (and in some cases unpublished) documents where compensation provision is embedded, to the HS2 NNL metric calculation.

10.32 The use of a biodiversity metric to inform compensation should never be the singular means of developing a compensation package. The benefits of its contribution as an offsetting tool in terms of standardised and accepted rules, its ability to challenge to do more, and its logical and transparent approach lead to the conclusion that an offsetting metric would be far more suitable for HS2 Phase 2. In addition to the gains for the natural environment, HS2 Ltd may benefit from avoiding many of the difficulties that have emerged as a consequence of seeking to implement a novel accounting approach in Phase 1.

Recommendation

10.33 In light of the wide ranging issues that 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.

Seeking to secure a net gain for HS2 Phase 2

10.34 Lessons learnt from the Phase 1 approach to biodiversity compensation should be identified and applied to Phase 2 of the scheme. The HS2 NNL metric calculations highlight that the scheme has not yet demonstrated NNL through the calculation. Natural England would strongly encourage HS2 Ltd to rectify the deficit and if possible go beyond an account balancing minimum level of compensation. Looking ahead to HS2 Phase 2, and having regard for the emerging commitments to achieving a net gain for biodiversity by other infrastructure providers such as Network Rail and Highways England, there is clearly an impetus to make a greater contribution to biodiversity conservation for HS2 Phase 2. The terms ‘net positive’ or ‘net gain’ are now commonly used to signal a commitment to achieving a biodiversity credit rather than simply preventing a deficit.

10.35 The NPPF requires development to achieve a net gain where possible. It is also a principle promoted by the aforementioned international biodiversity offsetting standard (BBOP, 2012). Natural England advises that in applying this national policy and conforming to international standards, it should be assumed that achieving a net gain is possible, unless there are clear justifications as to why it is not possible. If biodiversity declines are to be reversed, a net gain approach needs to be embedded as standard practice. Phase 2 is an opportunity for innovative and exiting biodiversity projects to be realised under a net gain approach, with the benefit of a considerable timeframe in which to develop stakeholder relations, commission research and gather evidence.

Recommendation

10.36 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.

Glossary of terms

ADDITIONALITY	The need for a compensation measure to provide a new contribution to conservation, additional to any existing values, i.e. the conservation outcomes it delivers would not have occurred without it. Source: McKenney & Kiesecker (2010).
ANCIENT WOODLAND	Ancient woods are defined in England as areas that have been continuously wooded since 1600. Source: Houses of Parliament (2014)
ASNW	Ancient semi-natural woodland. Ancient woodland, which is composed of native trees and shrubs, though it may have been previously managed. Source: Houses of Parliament (2014)
BIODIVERSITY	Biological diversity means the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems. Source: Convention on Biological Diversity
COMPENSATION	Measures to recompense make good for loss of biodiversity caused by a project. A more general term than biodiversity offset, which is one type of compensation. Compensation may achieve No Net Loss (in which case it is an offset) or it may involve reparation that falls short of achieving no net loss (and is therefore not an offset). Source: adapted from IUCN (2016)
EPN	Ecological place in network
ECOLOGICAL EQUIVALENCE	In the context of biodiversity offsets, this term is synonymous with the concept of 'like for like' and refers to areas with highly comparable biodiversity components. This similarity can be observed in terms of species diversity, functional diversity and composition, ecological integrity or condition, landscape context (e.g., connectivity, landscape position, adjacent land uses or condition, patch size, etc.), and ecosystem services (including people's use and cultural values). Source: BBOP (2012a).
ECOLOGICAL FUNCTIONALITY	The role and function that a habitat and supporting processes play in supporting an ecosystem. A habitat may be considered to have achieved ecological functionality when it fully supports all of the typical or target species.
FEP	Farm Environment Plan
IRREPLACEABLE HABITATS	Habitats that cannot be recreated within a specified time frame (typically, the timescale of the project)
METRICS	A set of measurements that quantifies results

NATURE IMPROVEMENT AREAS	Nature Improvement Areas (NIAs) were introduced by Government as focus areas for biodiversity restoration and enhancement in England. 12 NIAs were established in 2012 and awarded Government funding to initiate their nature improvement programme.
NNL	No-net-loss (see Chapter 3 for definition)
OFF-SETS	Biodiversity offsets are measurable conservation outcomes resulting from actions designed to compensate for significant residual adverse biodiversity impacts arising from project development after appropriate prevention and mitigation actions have been taken. The goal of biodiversity offsets is to achieve No Net Loss and preferably a Net Gain of biodiversity on the ground with respect to species composition, habitat structure, ecosystem function and people's use and cultural values associated with biodiversity. Source: BBOP (2012).
PAWS	Plantation on ancient woodland sites. Ancient woodland (see above) sites which were planted with (often non-native) broadleaved trees and conifers after the First and Second World Wars. PAWS are often less biodiverse than ASNW, but can retain some features of ancient woods. Source: Houses of Parliament (2014)
SELECT COMMITTEE	Select Committees can work in both the House of Commons and the House of Lords. These committees examine the work of Government Departments and the results of any such inquiries are normally made public.
SSSI	Sites of Special Scientific Interest. Sites providing statutory protection for the best examples of the UK's flora, fauna, or geological or physiographical features.

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Appendix A - Sensitivity Analysis

A1 In this section of the report we consider the implications for the no net loss (NNL) calculation of the findings of our review. HS2 Ltd has explained (Appendix A, HS2 2015a) how and why it adapted the Defra pilot offsetting methodology (Defra 2012) to '*address feedback that has arisen from use of the methodology within the pilot areas, and to ensure that it is suitable for use in support of a landscape scale project*'[10] and characterises in broad terms the expected effect of changes. There is, however, no detailed analysis of the consequences of these changes for the calculation of NNL.

A2 For the purposes of the Review, to allow us to examine the implications of the changes to the Defra methodology in HS2 Ltd's calculation, we used data and methodological information made publicly available by HS2 Ltd to undertake a 'sensitivity' analysis. This analysis was necessarily limited by information available and our ability to interpret it in the limited time available.

A3 The overarching question we sought to answer was:

Question: How do our recommendations affect the level of compensation required to achieve no-net-loss of biodiversity?

Methods

A4 The source of data for the analysis was 'HS2 Phase 1 No Net Loss (NNL) In Biodiversity January 2016' downloaded from the London-West Midlands Environmental Statement (November 2013) webpage on 'DATA.GOV.UK' on 6 June 2016. The authors of this Review did not use the GIS layers for undertaking or verifying any analysis as this was not possible in the time available.

A5 Biodiversity unit values were calculated from these data following the formulae and definitions set out by HS2 Ltd in its methodology paper (Appendix A, HS2, 2015a) and HS2 Ltd's submission to the Review (HS2, 2016).

A6 We are satisfied that these are the same data used in HS2 Ltd's NNL calculation methodology and results report (HS2, 2015a), the primary reference for this review, because we are able to recalculate precisely the same total figures for biodiversity units and habitat area for pre- and post-construction polygons using the data from DATA.GOV.UK as given in Table 3 of the HS2 report.

A7 The analysis reported here focuses on the key topics covered by the review, rather than being a comprehensive analysis of all changes made to the Defra pilot methodology. As stated above, the scope of the analysis was limited by the time and information available and a more comprehensive sensitivity analysis could be undertaken, a point we will return to in our recommendations.

A8 For illustrative purposes, the scale of habitat creation potentially represented by a given number of biodiversity units is also expressed as an equivalent area-

[10] HS2 (2015a) Appendix A, paragraph 1.5

based value for a selected habitat based on the typical values given in the post-construction dataset for newly created 'high distinctiveness' habitat of the relevant type (e.g. woodland, grassland, etc)[11].

Results

Irreplaceable habitats and designated sites

A9 Removing irreplaceable habitats and designated sites, and their respective compensation, from the NNL calculation and accounting for these separately need not have any knock-on consequences for the target number of biodiversity units required to achieve NNL for residual replaceable habitats if the latter has been fully compensated in the original calculation. This was investigated.

A10 Ancient woodland (including ancient semi-natural woodland and plantation on ancient woodland) is not specifically identified in the dataset we used for sensitivity analyses. It is possible to distinguish ASNW woodland polygons, as these are the only woodland to have a 'very high' distinctiveness weighting (x 8 multiplier), but PAWS woodland is assigned 'high' distinctiveness weighting (x 6 multiplier) and cannot be distinguished from other woodland with the same distinctiveness. Furthermore, it was not possible to identify which post-construction habitat polygons represent the compensation for losses of ancient woodland (including PAWS). It was not, therefore, possible (without a more detailed interrogation of the data provided by GIS layers) to exclude ancient woodland and its associated compensation habitat from the NNL calculation.

A11 Lowland fen is also considered to be an irreplaceable habitat. Fen habitat is distinguishable in the pre- and post-construction datasets. However, it is unclear if losses are exclusively compensated by fen creation and enhancement, or if other habitats also contribute (it is assumed not for present purposes). The total area of fen habitat is, however, very small (3.78 and 2.78 ha pre- and post-construction, respectively) and the inclusion or exclusion of this habitat from the no-net-loss calculation makes very little difference to the overall result (122.1 and 37.7 biodiversity units pre- and post-construction, respectively).

A12 Designated sites are not distinguished in the dataset, so it was not possible to remove SSSIs and their associated compensation from the NNL calculation and account for designated sites separately. Neither was it possible to investigate the implications of assigning all SSSIs with an automatic 'very high' (8 x multiplier) for distinctiveness, to recognise their ecological importance, or a 'good' condition (3 x multiplier), irrespective of current condition, to recognise that there should be measures already in place, independent of HS2, to achieve 'good' condition for these sites.

A13 Within the constraints of the review it was not possible to evaluate the effect of removing irreplaceable habitats and designated sites on the overall NNL calculation, or to present separate accounts for irreplaceable habitats, SSSIs and

[11] Values are based on the following typical multiplier values for newly created habitat in the post-construction dataset - distinctiveness: 6; condition: 2; ecological place in network: 2; difficulty: 0.67 (medium), and multipliers of 0.71 (ten years) and 0.33 (> 32 years) for time to target condition, for grassland and woodland respectively.

for the remaining replaceable habitats. At the second stakeholder workshop HS2 Ltd presented its own preliminary analysis of the contribution of ancient woodland. This analysis showed that excluding ancient woodland (and its associated compensation) from the NNL calculation reduces the post-construction deficit from 1066.2 to 472.7 biodiversity units, a saving which is equivalent to 111.8 ha of newly created 'high distinctiveness' woodland. While this analysis does not take account of the contributions of lowland fen or designated sites, it is predicted from this partial analysis that separately accounting for irreplaceable habitats, designated sites and replaceable habitats will reduce the number of biodiversity units required by HS2 Ltd to achieve no-net loss for the replaceable habitats that are lost.

A14 It is assumed, but was not possible to confirm in the time available, that interrogation of data held in GIS layers will allow habitat lost to be linked to its compensation, as it is a key principle of biodiversity metrics established by international practitioners (BBOP, 2012) to provide a record of how local compensation provision is to its respective loss.

Enhancement of existing ancient woodland habitat

A15 Habitat enhancement is used as an alternative method to habitat creation to compensate for some of the ancient woodland losses.

A16 The contribution made to the overall no-net-loss calculation of enhancing the condition of ancient woodland is expected to be relatively modest because it is relevant to only a single 8.8 ha area of woodland habitat (Black Waste Wood). It is potentially more significant for any calculation for ancient woodland, if this is accounted separately.

A17 The 8.8 ha has a biodiversity unit value of 355.9 in the post-construction calculation (which is equivalent to 67 ha of newly created 'high distinctiveness' woodland) while the units accrued from a uplifting the condition of the wood by a single step (from a condition score of 2 to 3) generates an estimated 213 units[12] (equivalent to about 40 ha of new woodland).

A18 On the evidence available, we can conclude that enhancing ancient woodland generates a relatively large number of biodiversity units per unit area of woodland, but its contribution to the overall NNL calculation is modest.

Addition of connectivity to the HS2 NNL metric

A19 HS2 has developed its own spatial risk multiplier (the 'ecological place in network', EPN) in place of that used in the Defra pilot methodology.

A20 It is not possible to compare the number of biodiversity units generated following the two approaches because the habitat polygons have not been scored according to the Defra multiplier, and comparison would require the application of an alternative way of re-scoring. It is, however, possible to evaluate the influence of the EPN multiplier on the no-net-loss calculation by either removing it from the calculation, or using a different set of multiplier weighting scores. For

[12] To estimate this we compared the biodiversity unit value of the 8.8 ha of woodland with a 'good' and a 'moderate' condition weighting once the improved condition had been attained (i.e. without risk multipliers for difficulty or time to target condition).

the purposes of this sensitivity analysis we have used scores that give this spatial multiplier less influence in the calculation (see Table A1), to represent a more precautionary approach that reflects the absence of scientific evidence underpinning use of this multiplier. The Warwickshire, Coventry and Solihull Defra offset pilot area similarly recommended reducing the weight afforded to the Defra spatial metric because its influence on offsetting calculations wasn't felt to be justified by the available evidence (Lowe, 2013). It recommended replacing the 1, 2 and 3 multipliers with values of 1, 1.5 and 2 respectively. These same lower values are currently used by Warwickshire County Council for offsetting calculations using its own adapted version of the Defra spatial metric (Warwickshire County Council, no date; Wood, B. pers comm.., 5th July 2016).

A21 The effects of removing and modifying the EPN multiplier are summarised in Table A1. For example, complete removal the EPN multiplier increases the deficit in biodiversity units from 3.3% to 7.9%, increasing the area of compensation habitat required by the equivalent of more than 400 hectares of high distinctiveness woodland, while retaining the multiplier but adopting reduced weightings results in a 5.1% deficit, and more modest increase in compensation habitat equivalent to 138 ha of woodland.

Table A1: Effect of removing or modifying the 'Ecological Place in Network' multiplier on the number of biodiversity units required to achieve no-net-loss (NNL)

Ecological place in network approach used	Pre-construction	Post-construction	Units required to achieve NNL	Additional biodiversity units	Equivalent area of woodland (ha) to achieve NNL [d]
EPN multiplier included [a]	33249.4	32183.2	+1066.2	-	200.9
EPN multiplier removed [b]	22467.4	20816.6	+1650.8	+584.7	622.2
EPN multiplier modified [b,c]	27847.4	26499.9	+1347.5	+281.3	338.6

Key

a: values are taken from Table 3 of HS2 (2015a). The pre-construction values calculated using the formula (as at 'b' below) is 33228.1 units[13]

b: values calculated using the formula in Table 6 of Appendix A of HS2 (2015a) with or without the EPN values included, as appropriate.

c: EPN multiplier scores used by HS2 (3, 2 & 1) were changed to 2, 1.5 & 1, respectively.

d: the value of the biodiversity units as an equivalent area of habitat is illustrated in terms of newly created high distinctiveness woodland, following the approach described in 'Methods' (paragraph A8) except that the EPN multiplier is either retained, removed or modified as appropriate.

A22 Using available evidence we were unable to compare compensation requirements generated by the Defra and HS2 approaches to spatial risk. However, it is clear that the inclusion of a spatial risk multiplier makes a significant difference the biodiversity units generated by compensation habitat.

[13] For 12% (or 2054 of the 16691) of habitat polygons in the preconstruction dataset there is a discrepancy between the 'biological units' value cited and the value that can be independently calculated using the formula in Table 6 of Appendix A of HS2 (2015). The overall effect of this discrepancy, in terms of total number of biodiversity units, is small: 1066.2 (original) vs 1044.8 (calculated using formula), a difference of only 21.4 units. However, the effect on individual polygons ranges from -17 units to +48 units, so there is potential for this discrepancy to affect calculations for specific habitat types, if it affects habitats differently (this was not investigated).

Target condition and scoring of hedgerows post-construction

A23 The way that the HS2 metric approaches hedgerow distinctiveness and condition is similar to the Defra metric, but the treatment of condition differs from the precautionary approach adopted by HS2 Ltd for other habitat types. The 'moderate' (2 x multiplier) cap on the condition rating that can be attributed to habitat creation targeted at 'high distinctiveness' habitats (which includes hedges) is removed so that both 'high distinctiveness' and 'good' condition (3 x multiplier) can be achieved in the calculation.

A24 All hedgerow habitats in the post-construction calculation have been assigned a 'good' (3 x multiplier) weighting. The difference that this makes to the biodiversity units generated, compared to the capped 'moderate' weighting for other habitat types is significant, and represents approximately 151 km of newly created hedgerow (see Table A2).

Table A2: Effect of condition multiplier on the biodiversity units generated by post-construction hedgerow creation

Condition multiplier used for hedgerow creation	Biodiversity units generated (linear-based units)[b]	Comparison to HS2 approach	
		Biodiversity units	Equivalent in hedgerow creation (km)
Good (3 x multiplier)	1926040.8	-	-
Moderate (2 x multiplier)	1284027.2	-642013.5	-150.7

Key

a: An equivalent length (km) value of hedgerow creation has been calculated following a corrected version of the approach described in footnote 37 in HS2 (2015a). The following values were used: condition: 3 ('high'); position within existing network: 2; difficulty or re-creating: 1 ('low'), and time to target condition: 0.71 (ten years). The latter two elements are not referred to in footnote 37, but are used in the calculation in associated Table 5 in HS2 (2015a).

Time to target condition

A25 In calculating the post-construction biodiversity units HS2 Ltd has used the time to target condition multipliers set out in the Defra pilot methodology. It has, however, assigned the multipliers to each habitat type according to its own analysis of the time it will take each habitat to be created (see Appendix A, Table 9, HS2, 2015a and HS2, 2015b). These periods take account of advice from Natural England.

A26 The times assigned by HS2 Ltd are not directly comparable to those cited in the Defra pilot methodology (see Appendix 2 Defra, 2012). HS2 time periods represent the time of establishment of 'ecologically-led habitat creation', whereas the Defra time periods represent the timescales for restoring habitats to ecological and ecosystems functionality. Surprisingly, there are no official or industry standard periods for creating or restoring different habitats in the UK suitable for offsetting schemes and in the time available we have been unable to identify any alternatives used in offsetting that could be used for comparison in an analysis. For example, the Warwickshire, Coventry and Solihull Biodiversity Offsetting Biodiversity Impact Assessment Calculator requires users to select the appropriate time to target condition on the basis of case-specific ecological

advice (Martland, 2014), rather than recommending or assigning specific values. In view of this, no sensitivity analysis was carried out.

Temporary land use

A27 In calculating the post-construction biodiversity units HS2 Ltd has used the time to target condition multipliers for most habitat types subject to temporary use during the construction of the high-speed railway line. Excluded from this approach are habitat types judged by HS2 Ltd to have a very limited biodiversity value. These are defined as "*arable fields, improved grassland, buildings, spoil heaps, bare ground, and amenity grassland*"[14]. In the post-construction calculation these habitats have been allocated a time to target condition multiplier of 1 (and a difficulty of restoration multiplier of 1) which assumes they are immediately available.

A28 HS2 Ltd concluded that applying a 5 year time to target condition multiplier skewed the calculation so that habitats with a very low biodiversity value had a "*disproportionate effect*" (HS2, 2016: paragraph 3.6.4). We investigated this.

A29 Table A3 summarises our findings. Including a 5 year time to target condition multiplier does indeed significantly reduce the contribution of these habitats to the post-construction calculation. As an alternative to taking no account of the time it takes for these habitats to be created, HS2 Ltd could apply time multiplier that is shorter and more proportionate. A 1 year multiplier, for example, would better reflect the time it takes to create habitats of low distinctiveness and thereby properly recognise the fact that they do make a small contribution to biodiversity, while avoiding any disproportionate effects from applying the normal 5-year minimum risk multiplier. The effects of a 1 year multiplier are shown in Table D3. Ideally, appropriate multipliers should be selected to reflect the time it takes to create a specific habitat type (e.g. a zero year multiplier would be appropriate for 'bare ground', but a 1 or more year multiplier more accurately reflects the time to create improved grassland).

A30 In conclusion, while use of the standard 5 year risk multiplier to temporary losses of low biodiversity value habitat does significantly affect calculations for a project like HS2, this can be addressed by adopting a more relevant risk multiplier as an alternative to using none at all in the calculation.

A31 There is a further generic issue affecting the treatment of land used temporarily, which relates to the period of time that such land is affected by construction activities. It is unclear how long works will typically last and it is also unclear whether or not this has been taken into account in selecting the time to target condition multiplier for these temporarily used habitat polygons (for example, if a polygon is to be used as a temporary construction site for 5 years, is the time multiplier adjusted to take account of this additional period before the habitat is re-created). This issue could be examined in sensitivity analysis but was not examined as part of this review.

[14] There is a discrepancy between this list of excluded habitat types, cited in paragraph 2.5.4. of HS2 (2015a) and that cited in paragraph 3.6.4 of HS2 (2016). In the latter it states that arable field margins are not included in the category of habitats treated as having low biodiversity value. The treatment of field margin polygons in the post-construction dataset is, however, consistent with the former and this is how they have been treated in our calculations.

Table A3: Effect of manipulating the 'Time to Target Condition' multiplier used for temporary habitats with a low biodiversity value in the post-construction calculation

Time to Target Condition approach used	Units contributed by 'low biodiversity habitats' [a]	Reduced contribution to post-construction calculation compared to HS2 approach	
		Biodiversity units	Equivalent area of woodland (ha)[b]
HS2 approach (1 x multiplier)	4742.4	-	-
1 year (0.965 x multiplier)	4576.7	-165.8	-31.2
5 years (0.83 x multiplier)	3936.4	-806.0	-151.9

Key

a: the habitats excluded were: B4 - Improved grassland; I2.2 – Spoil; J1.2 - Cultivated/disturbed land - amenity grassland; J1.1 - Cultivated/disturbed land – arable; J3.6 – Buildings, and 4 - Bare ground.

b: the value of the biodiversity units as an equivalent area of habitat is illustrated in terms of newly created high distinctiveness woodland, following the approach described in 'Methods' (paragraph A8).

Conclusions

A32 From the published literature on offsetting metrics it is evident that the choice or design of a metric (Bull et al, 2014) and the assumptions and values used in it (Galik & Cooley, 2012) can have a marked effect on offsetting calculations. This is also demonstrably the case with the HS2 metric.

A33 Within the limitations of this Review, we were unable to undertake a comprehensive sensitivity analysis of the changes made to the Defra metric by HS2 Ltd, and neither could we fully evaluate their overall net effect on the NNL calculation; moreover, it is unlikely that a full account is possible using the information collected by HS2 Ltd. On the basis of the analyses we did carry out, however, we can conclude that the changes made by HS2 Ltd to the Defra pilot metric have had more than a trivial impact on the calculation of NNL.

A34 In respect to the recommendations made in this Review concerning the calculation of NNL, those recommendations that were quantified are expected to increase the existing biodiversity unit deficit of 1066 units by a further 544 units (see Table A4). In terms of the area of compensation habitat required to achieve NNL, this roughly doubles the area of compensation habitat yet to be found[15]. This increase may, however, be negated, at least in part, if irreplaceable habitats and protected areas are removed from the NNL calculation and accounted for separately. To fully evaluate the implications of our recommendations further, more detailed, analysis will be required by HS2 Ltd.

[15] The area of compensation habitat required to compensate for a given number of biodiversity units is sensitive to the metric multipliers used in the calculation (i.e. if you change a multiplier then the number of units generated by a hectare of habitat changes). This is why it is possible for a 50% increase biodiversity units to result in a 100% increase in the area of habitat required.

Table A4: Effect of potential changes to the HS2 metric recommended in this Review

Approach	Pre-construction	Post-construction	Units required to achieve NNL	Additional biodiversity units	Equivalent area of woodland (ha)[a]
HS2 approach	33249.4	32183.2	+1066.2	-	200.9
Recommendations (partial)[b]	27847.4	26237.0	+1610.4	+544.2	404.7

Key

a: the value of the biodiversity units as an equivalent area of compensation habitat is illustrated in terms of newly created high distinctiveness woodland, following the approach described in 'Methods' (paragraph A8), except that the EPN multiplier is either retained or modified as appropriate. Alternatively, you can estimate the area deficit using the average number of units per hectare post-construction (total area: 6598.98 ha). Using the HS2 approach this gives a deficit of 218.6 ha (based on 4.88 units/ha) while for the Recommendations it is 405.0 ha (based on 3.98 units/ha).

b: The NNL analysis of our recommendations includes:

- Modifying the 'ecological position in network' weightings to 2, 1.2 and 1
- Allocating a 1 year 'time to target condition' weighting to temporary habitats with a low biodiversity value
- Using discounting rates calculated directly from 3.5%[16]

but excludes:

- Any recommendations relating to irreplaceable habitats and designated sites (including scoring of PAWS habitat and the condition of SSSIs)

A35 Put in the context of the total biodiversity unit requirement of Phase 1, HS2 Ltd's current calculated deficit represents only 3.2% of the total units needed to achieve NNL. Our recommendations are only expected to increase this to about 5.8%. The deficit remains, therefore, relatively modest.

A36 While it is acceptable to adapt an existing offsetting metric for the purposes of a specific project or in light of new evidence, it is our view that understanding of and confidence in, changes to any metric will be significantly enhanced by the publication of comprehensive sensitivity analyses. This is preferable to unquantified statements that simply indicate that a change is considered to be 'precautionary' or is necessary to avoid a 'disproportionate' effect of a multiplier in the original methodology. As such, the inclusion of sensitivity analyses should be considered to represent good practice and be a standard component of the methodology of new or modified offsetting metrics.

Recommendations

A37 We recommend that whenever a published metric is adapted for a specific project sensitivity analyses are conducted to evaluate the implications of any changes and the findings are published alongside the new metric's methodology.

[16] The discounting rates used by HS2 Ltd for 'years to target condition' (Table 8 of Appendix A, HS2, 2015) have been calculated from the values cited in Figure 7 of the Defra pilot methodology (Defra, 2012), which are in turn rounded-off values derived from the 3.5% annual discounting rate recommended in the Treasury Green Book (HM Treasury, 2011). Although the differences between the values used by HS2 Ltd and values calculated directly using the 3.5% rate are small, for a project of this scale correcting this discrepancy reduces by 152.8 biodiversity units the value of the post-construction habitats in the calculation (equivalent to approximately 29 ha of newly created woodland of high distinctiveness).

A38 We recommend that HS2 Ltd conducts a comprehensive sensitivity analysis of the adaptations it has made to the Defra metric insofar as this is possible using available information, and that the findings are published.