# Habitat Fragmentation Theme Plan

## Developing a strategic approach for Natura 2000 sites

*'Improvement Programme for England's Natura 2000 Sites – Planning for the Future'*

www.gov.uk/government/publications/improvement-programme-for-englands-natura-2000-sites-ipens

# Preface

## IPENS and theme plans

The Improvement Programme for England's Natura 2000 sites (IPENS), supported by European LIFE+ funding, is enabling Natural England, the Environment Agency, and other key partners to plan what, how, where and when to target their efforts on Natura 2000 sites and the areas surrounding them. As part of the IPENS programme, Site Improvement Plans (SIPs) and themed action plans (Annex 1) are being developed. SIPs provide an overview of the issues affecting features at the site level and the actions required to address them. Theme plans are high-level plans which aim to improve the way in which we manage a range of key issues on the Natura 2000 site series as a whole. Theme plans can provide an over-arching direction, recommendations or outline approaches to achieve target conservation status of Natura 2000 sites in England, to complement work already underway on individual sites. The plans do not have a legal status, and do not constitute a systematic evidence review, but are based on evidence and expert opinion. They are to inform action and initiatives of Natural England and its partners to help achieve the objectives of Natura 2000.

It is anticipated that Natural England and others, working with stakeholders and partners, will all play a role in implementing the theme plans. In the process of developing the theme plans, Natural England has approached key partners and delivery bodies to seek input and agreement on the roles in delivering the improvements, although in some cases these discussions have not yet been concluded. Recommended actions and next steps identified in the theme plans are not necessarily committed to or resourced but aimed at informing future resource decisions. Implementation of the theme plan recommendations will be via local prioritised delivery plans and coordinated through the IPENS After-Life Steering group, working with national and local delivery partner organisations.

## Audience

The habitat fragmentation theme plan is aimed at those responsible for the management of Natura 2000 sites, practitioners involved in planning and implementing actions to address habitat fragmentation on and around Natura 2000 sites and also anyone involved in setting national or local work priorities. All will play an important role in taking forward the actions identified in the plan. Natural England, sister agencies and public bodies, non-governmental organisations and major landowners including the Environment Agency, Forestry Commission, RSPB, National Trust, local authorities and the Wildlife Trusts will all find the plan of interest.

# Executive summary

This document is the theme plan for habitat fragmentation produced by the Improvement Programme for England's Natura 2000 sites (IPENS). It describes the importance of addressing habitat fragmentation to enable Natura 2000 sites to achieve their aim of acting as a network to assure the long-term survival of Europe's most valuable and threatened species and habitats. The plan describes an approach for objectively assessing which sites are likely to need the most action most urgently, and then provides advice on issues that should be considered when developing plans to improve connectivity. Priority actions to address outstanding issues are recommended and proposals for implementing the plan are made. It is structured to explain:

- the key issues, implications for Natura 2000 and drivers for taking action (Section 2);
- the principles behind improving connectivity, available mechanisms and funding opportunities (Section 3);
- the strategic approach recommended for Natura 2000 sites (Section 4); and
- priority actions and suggestions for implementation (Section 5).

## Overview

Evidence of the ecological impacts of habitat fragmentation on habitats and the species they support is well established, and targets to improve connectivity are now a fundamental part of international, European and national biodiversity legislation and policy. The process of fragmentation can have a number of distinct effects that can have serious consequences for ecosystem function and the species they support (Fahrig, 2003; Lindenmayer & Fischer, 2007), including:

- subdivision of species' habitat into smaller patches, some of which might be too small to contribute positively to a metapopulation across multiple sites in the long term;
- isolation of habitat patches and reduction of successful species immigration and emigration;
- increased 'edge effects' – environmental changes that occur at the boundary between one type of land cover and another;
- impaired function of some ecosystem processes, such as hydrological flows.

Natura 2000 sites are the most important wildlife sites in England, but sit within English landscapes that have suffered massive habitat loss and fragmentation. Ideally they should form the 'backbone' of a larger, functionally-connected network, acting as resilient core areas that will retain large and stable species populations and enable movement into and colonisation of surrounding landscapes. Therefore, to ensure that Natura 2000 sites are able to fulfil their aims as a network, it is essential that habitat fragmentation is addressed both within and around the sites. Addressing fragmentation will benefit not only protected sites, but also local communities through improved provision of ecosystem service benefits.

The main options available for establishing coherent and resilient ecological networks and for 'defragmenting' landscapes are neatly conceptualised by the principles summarised in the Making Space for Nature report as 'more, bigger, better and joined' conservation areas (Lawton, 2010). A number of detailed analytical tools are being developed to help identify priorities for management to enhance ecological networks and some of these are described in the plan. Additionally, hundreds of large-scale conservation initiatives across England are putting into practice the growing body of research and evidence, to create more coherent and connected natural landscapes (Macgregor and others, 2012; Eigenbrod and others, in press). Natura 2000 sites are an important component of

many of these.

Habitat fragmentation needs to be assessed in a precautionary manner, consistently reported across the Natura 2000 network and actions to address it need to be embedded into the management of all Natura 2000 sites, so that favourable conservation status can be achieved and maintained in the longer term. To do this, a national approach is required for Natura 2000 sites with the aims of:

- Developing a strategic approach to habitat fragmentation for Natura 2000 sites in England, including improvements to datasets and analytical tools in order to achieve a robust and consistent evaluation methodology and means of identifying priority improvements;
- Developing a funding strategy with partner organisations to influence funding bodies, increase the amount of external funding allocated to connectivity projects and improve the likelihood of high priority projects being implemented;
- Working with partner organisations to ensure that landscape scale conservation initiatives are better targeted to benefit Natura 2000 sites.

Section 4 of the theme plan starts to address the first of these aims by proposing a two-part strategic approach, comprising a spatial prioritisation exercise followed by a framework to guide thinking when developing local connectivity plans. Implementation of this in combination with the use of other complementary tools, will ensure that a significant step towards achieving good conservation status can be made.

## Key messages

- The remaining patches of semi-natural land cover in England are mostly small and fragmented: 50 % of the geographically separate Natura 2000 site units are smaller than 30ha and 77% of SSSIs and 98% of Local Wildlife Sites are smaller than 100ha.
- For a given level of fragmentation, some habitats will be more badly affected than others and the effects will be more serious for some species than others. This largely depends on the degree to which ecosystem functioning is affected and the particular habitat requirements of each species.
- There is increasing interest in the benefits of creating greater habitat heterogeneity, although more heterogeneous landscapes could be seen as more fragmented. Many recommended measures to increase heterogeneity and structural complexity are very small scale and so can generally be seen as compatible with efforts to reduce fragmentation.
- It is clear that while further research may be required into specific relationships between fragmentation / connectivity of semi-natural land cover and ecosystem services, in general any management actions to reduce fragmentation are likely to have the potential to increase ecosystem service provision, and this should be taken into consideration when planning management actions.
- The spatial prioritisation approach proposed in this report uses one of a range of recently developed analytical tools. Further work is needed to compare different approaches and explore how they can be best used by practitioners.
- Over 36% of the Natura 2000 network in England is already within landscape scale conservation initiative areas, and will be benefiting from the work they are delivering.
- Whilst a range of mechanisms are available to improve habitat connectivity, not least Countryside Stewardship, their inherent limitations often mean that it is difficult to secure appropriate improvements in the locations where they are most needed.
- Building trusting relationships with the landowners and farmers adjacent to important conservation sites helps to establish the social networks that are essential for coherent and resilient ecological networks. Failure to consider the socio-economic aspects of habitat fragmentation and restoration, of importance to landowners, risks jeopardising the final outcomes.

- It is essential that the location and long-term viability of interventions aiming to improve connectivity are considered thoroughly, in the context of needing to target limited resources and challenges in securing long-term funding.

## Priority Actions

To ensure the long term resilience of Natura 2000 sites in England to the effects of habitat fragmentation and secure good conservation status, it is proposed that the strategic approach outlined in the plan is applied across the Natura 2000 network to prioritise where action is required most urgently. In addition to this, a range of priority actions are suggested which will help to address other aims described above, including understanding how new analytical tools can be best used; further adapting the strategic approach for habitats not already covered; and making model outputs more accessible.

# Contents

# 1. General background

Habitat fragmentation has been identified as a priority theme because of its widespread impact on many interest features and supporting habitats of both Special Areas of Conservation (SAC) and Special Protection Areas (SPA). Knowledge about the impacts of habitat fragmentation is greatest for terrestrial, wetland and freshwater environments. Research is most developed there, and there are a range of opportunities for intervention. Marine habitats may be considered inherently more connected due to the nature of the marine environment and facility for larval dispersal. Experimental studies have shown, however, that there is the potential for effects on marine epifaunal macroinvertebrate communities at a small scale (Pierri-Daunt and Tanaka, 2014) and the recent development of the Marine Protected Areas network has considered 'connectivity' as part of its design principles (JNCC & Natural England, 2010). The focus of this theme plan is on terrestrial sites because of the availability of assessment methods, but it is recognised that further work is required to test if similar methods can be applied to marine sites too.

Evidence of the ecological impacts of habitat fragmentation on habitats and the species they support is well established, and targets to improve connectivity are now a fundamental part of international, European and national biodiversity legislation and policy. Specific drivers exist which require the full implementation of the Birds and Habitats Directives, which will mean that duties to improve the coherence of the Natura 2000 network via restoration and creation of habitats with improved connectivity must be met (Article 3 Birds Directive and Article 10 Habitats Directive).

Despite clear evidence of the effects of fragmentation, empirical evidence of its impact on protected sites, including Natura 2000 sites, is more difficult to gather at a national level. Protected site recording systems have tended not to require specific data on fragmentation, so it is usually hidden under other reporting categories, such as 'development pressure' or 'changes to agricultural practices', or in some cases it is assumed that the majority of fragmentation has happened historically. This is true for SSSI recording in England and for Habitats Directive Article 17 reporting. Some data is available for SPAs in the Birds Directive Article 12 report (JNCC, 2013), although even here declining numbers of only three species (common scoter, curlew and stone curlew) are clearly related to and presumably affected by habitat fragmentation (based on English interpretation of the European reporting categories). Reporting therefore tends to focus on management of the remaining habitat fragments.

Data from the Site Improvement Plans (SIPs) that have been developed for every Natura 2000 site in England as part of the IPENS project show that, based on local site knowledge, habitat fragmentation effects are being seen or are expected at 28 locations across England (Annex 2), with a noticeable southerly bias, the most prominent of which in Figure 1 are Breckland SPA, Thames Basin Heaths SPA and the SAC and SPA of the Dorset heaths. SIPs report that 35 Natura 2000 interest features are affected, the most frequently cited being H6210 important orchid sites (6 records), H4030 European dry heaths (5 records), S1065 Marsh fritillary butterfly (4 records) and S1166 Great crested newt (4 records). It is likely that this list is not comprehensive as its compilation was reliant on subjective site-based knowledge, rather than an objective assessment process and so probably reflects the interests and knowledge of site managers or responsible officers.

A common assessment approach is clearly required to improve the consistency of these data across the whole of England Natura 2000 network. This plan seeks to outline a framework approach that may be used by practitioners in Natural England and partner organisations working with land owners / managers.

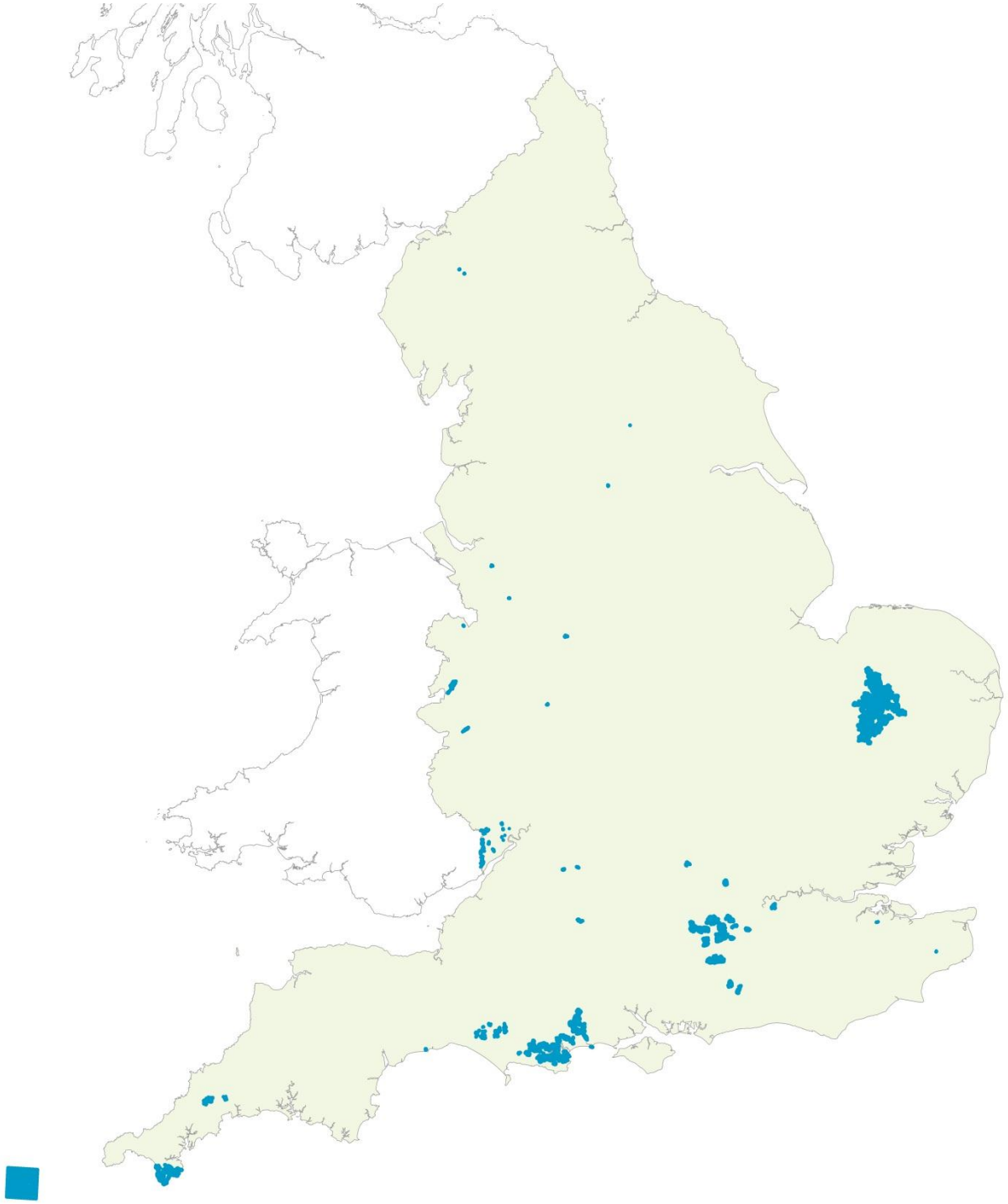


**Figure 1. Natura 2000 sites with Site Improvement Plans that report habitat fragmentation as an issue**

# 2. Theme description

## 2.1 Description of key issues and scale of problem

### What is habitat fragmentation and why is it a problem?

Habitat fragmentation refers to the breaking up of larger areas of habitat into smaller pieces. It is distinct from (but often occurs in parallel with) habitat loss, ie a reduction in the overall amount of natural land cover. The broad process of 'fragmentation' can have a number of distinct (though again linked) effects that can often have serious consequences for ecosystem function and the biodiversity and ecosystem services it supports (Fahrig, 2003; Opdam & Wascher, 2004; Lindenmayer & Fischer, 2007; Lindenmayer, 2009). These include:

- Subdivision of species' habitat into smaller patches, some of which might be too small to continue to support populations of a species, or to maintain stable / viable populations (or metapopulations across multiple sites) in the long term.
- Isolation of habitat patches and reduction of successful species immigration and emigration. This can increase the likelihood of inbreeding and loss of genetic diversity, and of local population extinction through chance events (combined with a decline in the likelihood of re-colonisation). This could become an increasingly serious issue as the climate continues to change and populations in isolated patches are both at higher risk of being affected by extreme events and unable to shift as their suitable climatic environment 'moves'.
- 'Edge effects' – environmental changes that occur at the boundary between one type of land cover and another (for example disturbance from a human-modified area affecting an adjacent patch of semi-natural vegetation). These can include both biotic and abiotic effects, such as structural damage or change to vegetation; changed temperature, light and evaporation levels; altered nutrient cycling; the deposition of fertilisers and pesticides; changed patterns of plant growth, and increased effects of predators and invasive species. Some of these effects can penetrate a long way into a patch.
- Impaired function of some ecosystem processes, such as hydrological flows. This can affect the stability and viability of the system and not only its capacity to provide habitat for species (as outlined above) but also the services it provides to people.

Habitats tend to be more seriously affected by fragmentation when it leads to adverse impacts on ecosystem functioning (UK National Ecosystem Assessment, 2011). Whilst small patches of lowland grassland may be able to retain the majority of their component species for relatively long periods, for habitats such as wetlands which are dependent on an intact hydrological system, even minimal fragmentation can start to seriously impair functioning. So, for a given level of fragmentation, some habitats will be more badly affected than others. At the species level, certain traits or behaviours have been found to be predictive of sensitivity to the effects of fragmentation.

### Habitat fragmentation has species-specific effects

Although the term 'habitat' is often used loosely in conservation literature (including in this report) to refer to different types of natural land cover (eg mixed woodland, wetland), strictly speaking habitat refers to the resources necessary to support a particular species – ie each species has its own habitat (Hall and others, 1997, Lindenmayer and Hobbs, 2007). This can be an important distinction, because it means that a certain level of fragmentation in a landscape, as perceived by humans, will be more serious for some species than others. Some adaptable generalist species might need only a small coverage of semi-natural land cover in a landscape, while for some specialist species even a large patch of what appears to be suitable vegetation might not actually provide the resources a species needs. For this reason, and because different species have different spatial requirements and abilities to disperse and cross gaps in the landscape (Eycott and others, 2011), the relative importance of different

sizes, shapes and spatial configurations of vegetation and other features in the landscape varies among species. Henle and others (2004) in an analysis of published literature on populations of a wide range of taxa found good empirical support for six traits as predictors of sensitivity to habitat fragmentation, including population size, competitive ability and microhabitat specialisation. In a study of butterflies and moths, Öckinger and others (2010) found that species richness increased the greater the habitat area and connectivity between habitats, but that life-history traits significantly modified this response. Species which were less mobile, had low reproductive rates and which had a limited range of larval food plants were more sensitive to habitat loss and fragmentation than those which were more mobile, had high reproductive rates and a wider range of larval food plants. Further information on species responses is in Section 3.1.

Our knowledge of spatial habitat requirements for different species is imperfect (though improving as the result of a lot of recent and current research), but recently-gathered information (outlined below) on the amount and configuration of semi-natural land cover in England, coupled with recent steep declines in many species, suggest that fragmentation is so severe that it is an issue affecting a very large number of species.

### The scale of the problem – England's fragmented landscapes

The landscape of the UK has changed markedly during the last 60 years with the expansion of enclosed farmlands, woodlands and urban areas, and the contraction and fragmentation of semi-natural grasslands, upland and lowland heaths, freshwater wetlands and coastal margin habitats (UK National Ecosystem Assessment, 2011).

Information collated for the Making Space for Nature report (Lawton and others, 2010) emphasises just how small and fragmented most of the remaining patches of semi-natural land cover in England are. Among the figures quoted in the report (and other recent publications):

- 77% of SSSIs and 98% of Local Wildlife Sites are smaller than 100 ha;
- For several Biodiversity Action Plan (BAP) priority 'habitats' the median patch size remaining is smaller than 2 ha;
- The 90th percentile patch of almost all of these land-cover types is under 100 ha.

The Dorset Heathlands provide a good example of the extent of fragmentation that has occurred over the last 200 years at the landscape scale. In the early 1800s heathland covered most of south-east Dorset. Some 86% of Dorset's heathland has been lost since then, and the surviving area is broken into more than 150 fragments (RSPB, URL: https://wwww.rspb.org.uk/whatwedo/projects/details/218968-dorset-heathland-project).

Having small sites means there is lots of 'edge' and little 'interior'. A recent study of forest patches in England (Riutta and others, 2014) found that 37 % of forest is within 30 m and 74 % within 100 m of the nearest edge. For ancient woodlands, 28 and 62 % of the area was within 30 and 100 m of the nearest open edge (see also Watts, 2006). This means that a very large proportion of the total forest area is likely to be subject to edge effects as outlined above, such as more variable temperatures, increased evapotranspiration and drift of agricultural chemicals with consequent effects on woodland species.

In some cases, having very small sites might not be such a problem if there were simply a much greater coverage of high quality habitat (including protected areas and other semi-natural land cover) across the country, and if the intervening 'matrix' of land had environmental conditions suitable for wildlife. When habitat quality is high with a diverse mosaic of plant structure and there is an overall high level of natural land cover in the landscape, smaller patches can deliver greater benefits to a network and are more likely to support species populations. However, the problems of fragmentation in England are compounded hugely by the facts that there is so little semi-natural land cover left, that less than 10% of the country is protected for conservation, and that agricultural intensification and built development in the areas between semi-natural patches has destroyed habitat for many species, and created barriers to movement and greater disturbance on the edges of remaining semi-natural areas, thus increasing fragmentation and its associated effects. It is clear from recent national studies such as the UK National

Ecosystem Assessment (2011) and Making Space for Nature (Lawton, 2010) that there are few if any sufficiently large and diverse semi-natural areas left in England.

The level of fragmentation varies spatially. Figure 2 below represents levels of fragmentation by National Character Area (NCA) and clearly shows that some parts of England are more severely affected by habitat fragmentation than others. 'Permeability' in the figure heading refers to the ease by which species can move through the landscape.

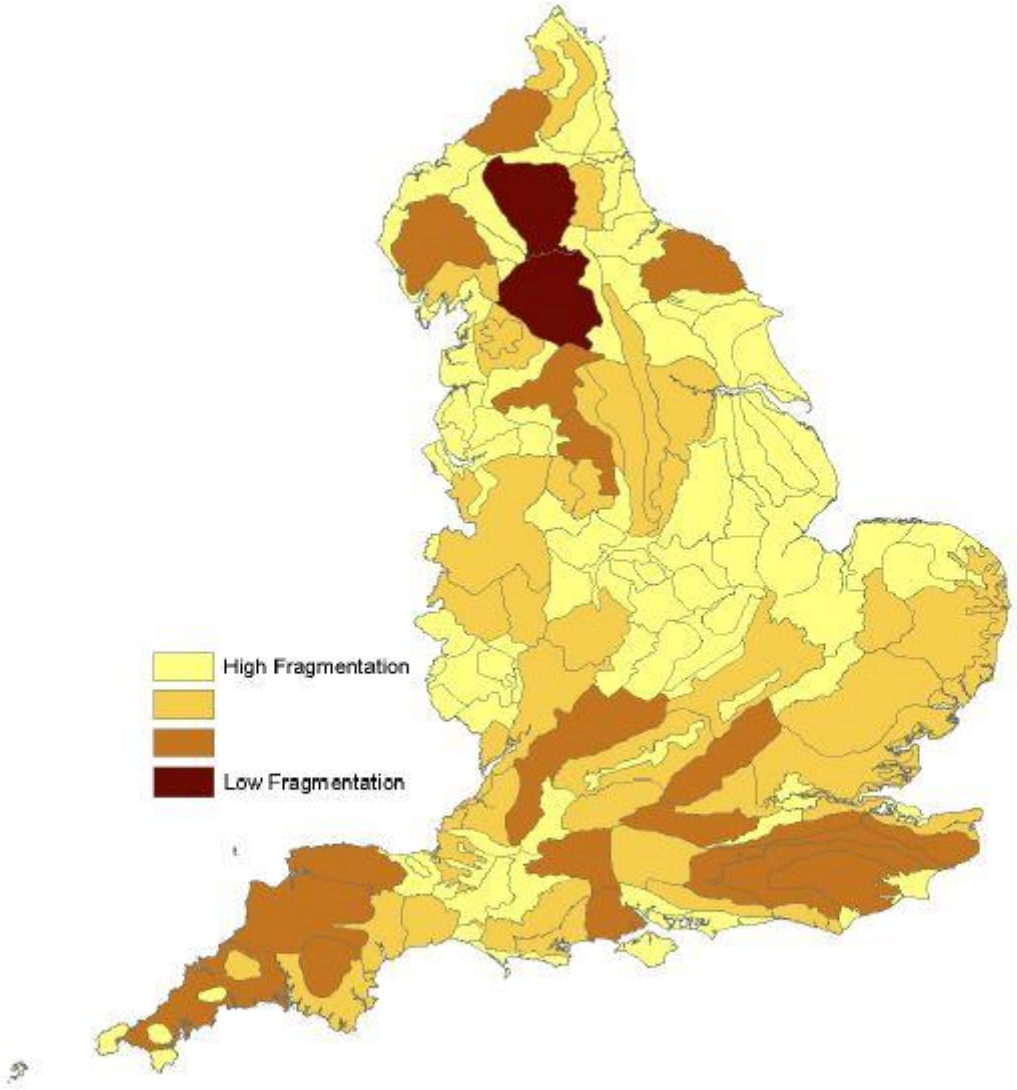



**Figure 2 Levels of Fragmentation across National Character Areas:** This analysis takes account of habitat extent and permeability of land between habitat patches to produce a ranking from areas where habitats are most fragmented (lighter) to less fragmented and more connected (darker). From an analysis carried out by Dr R Catchpole, Natural England, reproduced in Lawton and others (2010).

## Fragmentation, heterogeneity and the Mosaic Approach

As noted above, improving habitat 'quality' is an essential foundation of strong ecological networks. In simple terms this means ensuring the management of existing sites, or creation/restoration of new ones, actually provides habitat for all the species we want to conserve. This sounds obvious, but even if an area appears to human eyes to be the right 'habitat' it might not provide the necessary resources for particular species to live there (Lindenmayer & Fischer, 2007). For example a recent report by Woodcock and others (in press) noted that "grasslands dominated by grass species only (ie with no or few flowering forbs) are of little to no value [for invertebrates]".

Many conservationists are becoming increasingly interested in the potential benefits of creating greater

heterogeneity and 'mosaics' of vegetation and other land cover. There is evidence that heterogeneity in habitat structure can be more important than site size in determining the species diversity of wildlife sites (Báldi, 2008), and that some relatively small structural elements can have a very large benefit in proportion to the area they occupy (eg Manning and others, 2006, Fisher and others, 2010). So, by increasing the heterogeneity of a site, or group of sites, the number of species that can be supported might increase. It has been suggested (P. Brotherton, *pers. comm*) that promoting greater heterogeneity might help to overcome the problem that conservation sites in England are small and fragmented. It could also help to provide a range of microclimates (eg warm dry areas, cool moister areas) that will help provide conditions for species to persist under unfavourable conditions resulting from climate change (Suggitt and others, 2014).

An analysis by Webb and others (2010) of the requirements of priority terrestrial species identified a number of habitat attributes that are a common requirement of a large number of species. Common to most habitats is some form of structural variation resulting from occasional disturbance and periods of stability. Other important factors are sheltered conditions, exposure to sunlight, and large-scale mosaics of land cover, while wetland species are particularly associated with good water quality and hydrological processes. The analysis highlighted the need to recognise habitat mosaics as being important in their own right, and to allow for flux and change between habitats. It suggested that in order to conserve species there should be a more dynamic approach to habitat management, with an emphasis on the creation of habitat heterogeneity, within sites, between sites, and over time.

Based on this analysis, Natural England (2013) has developed the Mosaic Approach, presented (in a series of illustrated guides) as a way of looking at habitats that focuses on the requirements of the priority species that they support. It picks out the attributes that are the most important for priority species. The Mosaic Approach also highlights the factors that influence change in a habitat and so determine the key elements within it, particularly the ecological processes of disturbance (including human-induced disturbance through management) and succession. The alternation of disturbance and succession gives rise to structural variation at different spatial scales in a landscape.

At first glance, this might seem to contradict some aspects of combatting fragmentation – a more heterogeneous site or landscape could be seen as a more fragmented one. However, the two ideas are compatible. Many of the measures recommended in the Mosaic Approach are very small elements such as small patches of bare ground, dead wood, scattered trees and grass tussocks, which should be easy to incorporate into a patch and are likely to have a highly beneficial impact on habitat potential and the range of niches provided. Larger-scale mosaics can be formed by the juxtaposition of different land cover types. Here a balance probably does need to be struck between creating greater structural variation and maintaining some large blocks of a particular land cover for these species that require 'patch interior' conditions. Heterogeneity at this scale does not necessarily need to be confined to an individual site (and, particularly when sites are small, might be better approached across groups of nearby sites). For example, Fuller and others (2014) showed that there are six different structural types of woodland that together will support the full range of woodland birds, and suggested that all of these woodland types should be provided within a landscape.

Natural England and its partners are doing further research into the heterogeneity/mosaic concept to better understand how it can be incorporated into the design of ecological networks.

## Fragmentation and ecosystem services

Ecosystem services are defined as services provided by the natural environment that benefit people; the outputs or outcomes that directly and indirectly affect human wellbeing. Biological diversity, including the number, abundance, and composition of genotypes, populations, species, functional types, plant and animal communities, and landscape units, plays a vital functional role within ecosystems, and there is high certainty that, as a result, biodiversity strongly influences the provision of ecosystem services and therefore human well-being (Diaz and

others, 2005). Significant gaps in our knowledge remain, but there is an emerging scientific consensus on the need to sustain biological diversity to protect the delivery of ecosystem services (Elmqvist and others, 2010). Processes frequently affected directly by biodiversity include pollination, seed dispersal, climate regulation, carbon sequestration, agricultural pest and disease control, and human health regulation. Also, by affecting ecosystem processes such as primary production, nutrient and water cycling, soil formation and retention, biodiversity indirectly supports the production of food, fibre, potable water, and medicines (Diaz and others, 2005).

There is increasing concern that the ongoing loss of biodiversity, including changes resulting from habitat fragmentation, may compromise the provision of ecosystem goods and services in the near future. The UK National Ecosystem Assessment (2011) concluded that the UK's ecosystems are currently delivering some services well, but others are still in long-term decline. Fragmentation of hydrological systems and natural vegetation cover has led to a loss of functional integrity and compromised the ability of sites to deal with pressures and provide services that increase resilience to change; for example, the draining of uplands and hydrological separation of rivers from their flood plains can worsen flooding downstream.

Further research is required into specific relationships between fragmentation / connectivity of semi-natural land cover and ecosystem services. For example, there is uncertainty about how ecosystem services are related to ecosystem structure, functioning, habitat type, size, spatial extent and fragmentation of freshwater systems. We lack precise knowledge of the importance of connectivity, and, in particular, the role of the many small wetlands or water bodies whose number remains poorly estimated and location often unrecorded. However, in general any management actions to reduce fragmentation are likely to have the potential to increase ecosystem service provision, and this should be taken into consideration when planning management actions. Carefully targeted investment in habitat creation or restoration can bring significant environmental and social benefits. The Natural Capital Committee has found that there is a strong economic case for making this type of investment, including woodland planting, peatland restoration and wetland and intertidal habitat creation (Natural Capital Committee, 2015). Ecosystem service benefits can often be increased through relatively simple changes around a site even before the biological components have had time to fully recover. Changes may include actions such as:

- management of the hydrological unit around a wetland site, helping to reduce the impact of diffuse pollution, or allowing succession to wet woodland or grazing when water levels allow.
- allowing rivers more space to move across and interact with their floodplains naturally.
- use of buffer land around a site when nutrient enrichment is affecting the functioning of the ecosystem.

For some sites it will be vital to take actions such as these in order to restore them to favourable condition, although this will often require influencing the management of surrounding land.

Our understanding of the functional role of biodiversity in key ecosystem processes is being significantly improved by a six year research programme (2011-2017), called Biodiversity and Ecosystem Service Sustainability (BESS). Further details can be found at www.nerc-bess.net/.

## Implications for Natura 2000 sites

Natura 2000 sites have been established by the EU as a functional network of nature protection areas with the aim of assuring the long-term survival of Europe's most valuable and threatened species and habitats. It is not a system of strict nature reserves, but the emphasis is on ensuring that future management is sustainable both ecologically and economically (URL: http://ec.europa.eu/environment/nature/natura2000/index_en.htm). Natura 2000 sites are the most important wildlife sites we have in England, but clearly sit within the fragmented context described above.

The Natura 2000 network in England is comprised of many geographically separate units. Although there are a few

very big units (such as those which comprise The Wash SPA / The Wash and North Norfolk Coast SAC, Outer Thames Estuary SPA, and North York Moors SAC/SPA) that together make up most of the Natura 2000 network in terms of area (around 90%) (Figure 3), the rest of the network is composed of a very large number of relatively small, geographically separate units. Half of the geographically separate units[1] that make up the Natura network in England are smaller than 30ha (Natural England unpublished analysis; Figure 4). Land cover within 500m of the boundaries of Natura 2000 sites is heavily dominated by agriculturally modified grassland and arable land (Figure 5), suggesting that many sites, particularly the small units of land, might be subject to negative edge effects.

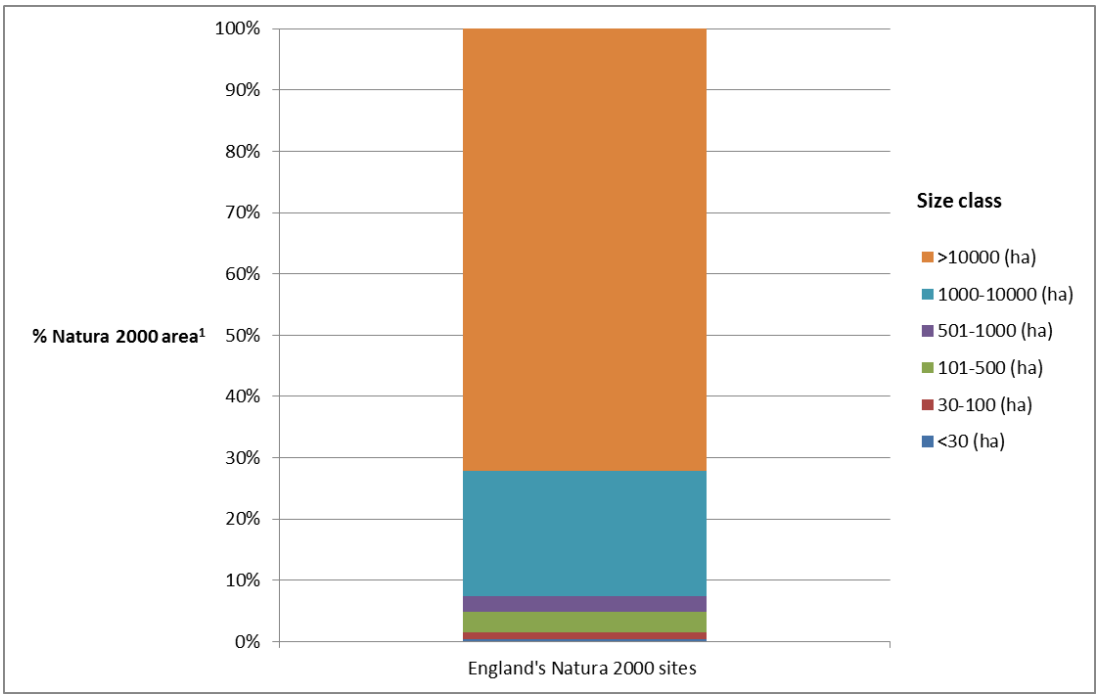



**Figure 3. Size distribution of geographically separate units by area, showing that >90% Natura 2000 area in England comprises large units >1000ha.**

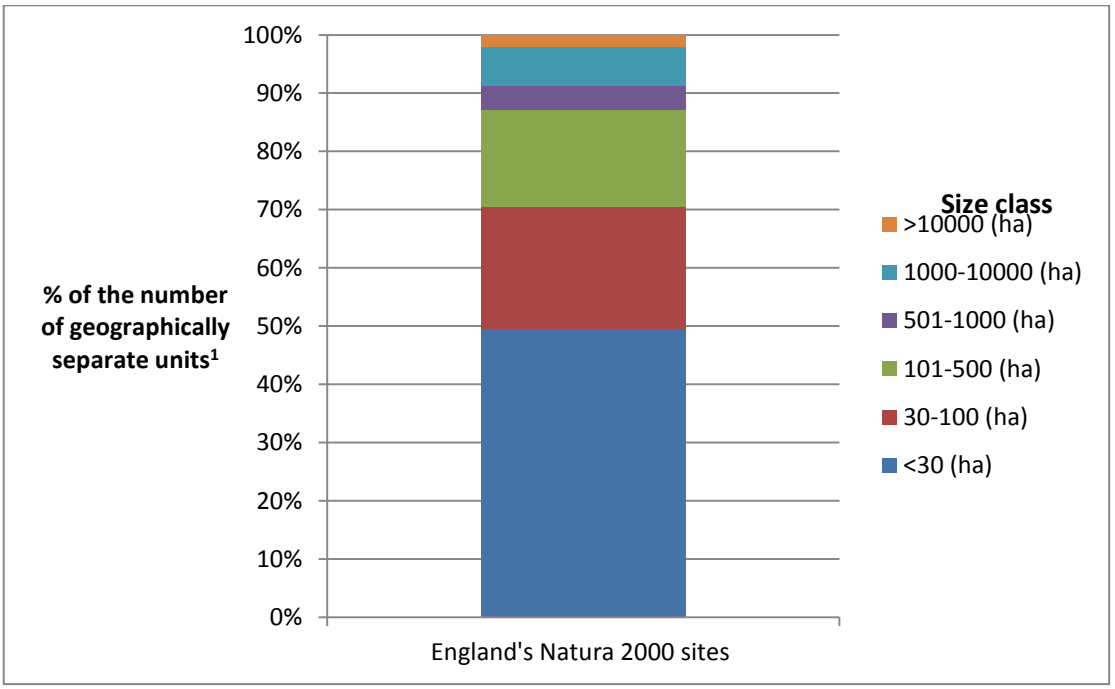



**Figure 4. Size distribution of geographically separate units by number, showing that 50% of the units in England are <30ha.**

[1] Excluding geographically separate units which are less than 1ha, which are mostly a very large number of coastal rocks.

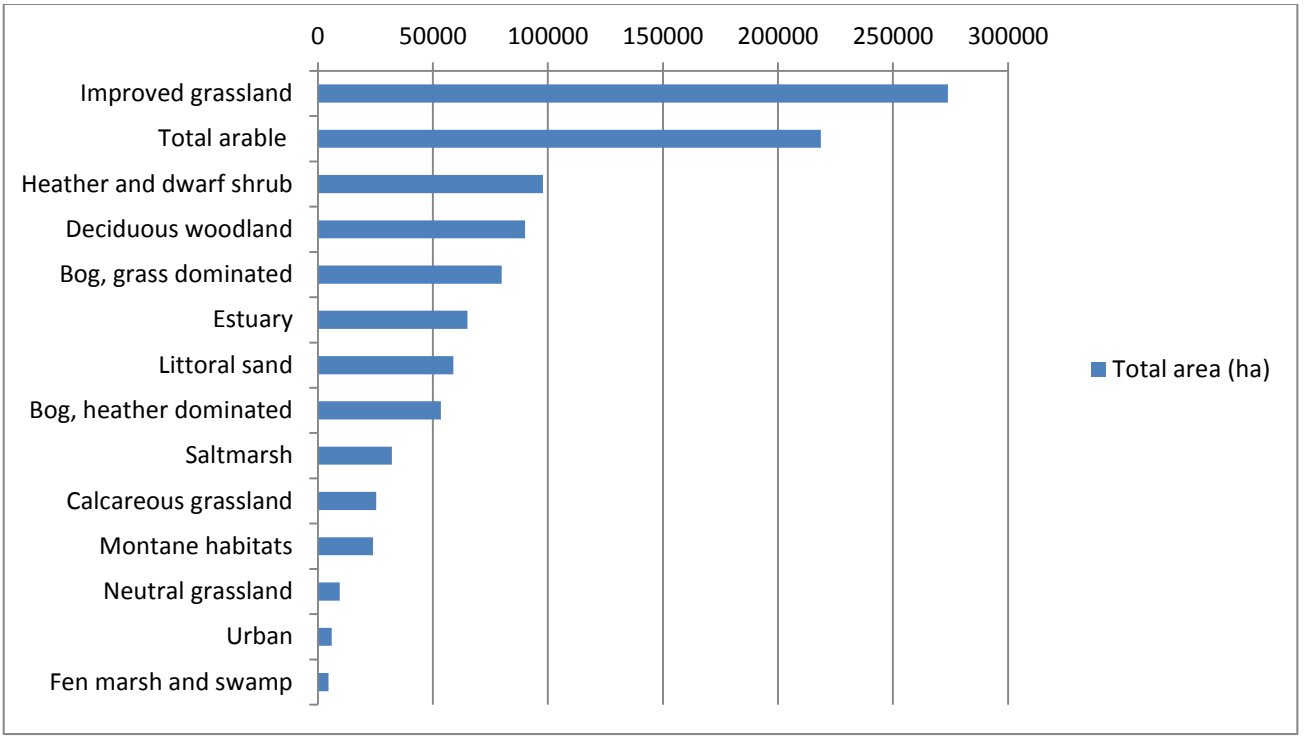



**Figure 5. Land cover within 500m of Natura 2000 site boundaries (selected land cover types)**

Ideally Natura 2000 sites should form the 'backbone' of a larger, functionally-connected network, acting as resilient core areas that will retain large and stable species populations and enable movement into and colonisation of surrounding landscapes. They also have considerable potential to provide ecosystem services. Therefore, to ensure that Natura 2000 sites are able to fulfil their aims as a network, it is essential that habitat fragmentation is addressed both within and around the sites, including strengthening functional ecological links with other conservation areas such as SSSIs, LNRs, Local Wildlife Sites and remaining priority habitats shown on Natural England inventories by restoring degraded or lost habitats.

28 Site Improvement Plans for Natura 2000 sites report issues relating to habitat fragmentation or habitat connectivity. These are listed in Annex 2. This list is not comprehensive as it is based on subjective site knowledge rather than an objective assessment process.

Natural England's National Biodiversity Climate Change Vulnerability Assessment (NBCCVA) includes a habitat fragmentation metric, which has been used to rank Natura 2000 sites in England by average fragmentation. Further detail of how this analysis may be used to make a more objective assessment for the Natura 2000 network is presented in section 4.

## 2.2 Relevant national and international policies

There are a number of international, European and national legal and policy drivers to reduce habitat fragmentation and increase connectivity. These include specific requirements for Natura 2000 sites and also general ecological ambitions.

### International conventions and strategies

A global mandate for the improvement of biodiversity was set with the adoption of the 'Strategic Plan for Biodiversity 2011-2020' under the Convention on Biological Diversity following the Nagoya conference in 2010. This includes a set of targets known as the 'Aichi biodiversity targets'. Of relevance to habitat fragmentation is 'Strategic Goal C' which is to *'improve the status of biodiversity by safeguarding ecosystems, species and genetic diversity.'* Under this, 'Target 11' states:

"*By 2020, at least 17 per cent of terrestrial and inland water, and 10 per cent of coastal and marine areas, especially areas of particular importance for biodiversity and ecosystem services, are conserved through effectively and equitably managed, ecologically representative and well connected systems of protected areas and other effective area-based conservation measures, and integrated into the wider landscapes and seascapes*."

This international target sets the context for European and national biodiversity strategies and the drivers they provide for improvements to habitat connectivity.

### European legislation and policy

European requirements to create and restore habitats for birds date back to the Birds Directive of 1979 (79/409/EEC). Article 3 states that the preservation, maintenance and re-establishment of biotopes and habitats shall include primarily four measures:

a) creation of protected areas;
b) upkeep and management in accordance with the ecological needs of habitats inside and outside the protected zones;
c) re-establishment of destroyed biotopes;
d) creation of biotopes.

Article 10 of the Habitats Directive 1992 92/43/EEC includes a specific requirement relating to improvements to habitat connectivity via linear features and functional 'stepping stones':

*"Member States shall endeavour, where they consider it necessary, in their land-use planning and development policies and, in particular, with a view to improving the ecological coherence of the Natura 2000 network, to encourage the management of features of the landscape which are of major importance for wild fauna and flora.*

*Such features are those which, by virtue of their linear and continuous structure (such as rivers with their banks or the traditional systems for marking field boundaries) or their function as stepping stones (such as ponds or small woods), are essential for the migration, dispersal and genetic exchange of wild species".*

Implementation of both of these legal requirements has been supported by the production of guidance on the maintenance of landscape connectivity features (Kettunen and others, 2007). This provides an important framework for the assessment, planning and implementation of connectivity measures.

To help Europe meet its commitments under the Convention of Biological Diversity, an EU biodiversity strategy to 2020 was published in 2011 (European Commission, 2011). This describes a framework for action, based around six interdependent targets, two of which are to address the specific goal of protecting and restoring biodiversity and associated ecosystem services:

- **Target 1** - To halt the deterioration in the status of all species and habitats covered by EU nature legislation and achieve a significant and measurable improvement in their status so that, by 2020, compared to current assessments: (i) 100% more habitat assessments and 50% more species assessments under the Habitats Directive show an improved conservation status; and (ii) 50% more species assessments under the Birds Directive show a secure or improved status;
- **Target 2** - By 2020, ecosystems and their services are maintained and enhanced by establishing green infrastructure and restoring at least 15 % of degraded ecosystems.

Importantly, these targets provide a strong steer that both the Birds and Habitats Directives should be fully implemented, and try to ensure better functional connectivity between ecosystems within and between Natura 2000 areas and in the wider countryside.

### National policies

There is a very strong Government general policy drive for addressing habitat fragmentation in the 2011 **Natural**

**Environment White Paper** 'The natural choice: Securing the value of nature' (Defra, 2011a) which states that:

*"Past action has often taken place on too small a scale. We want to promote an ambitious, integrated approach, creating a resilient ecological network across England. We will move from net biodiversity loss to net gain, by supporting healthy, well-functioning ecosystems and coherent ecological networks".*

It notes that "achieving this will require a fundamental shift in approaches to conservation and land management." Among the commitments made in the paper, several specifically address large-scale conservation and ecological networks. These are listed in Annex 3.

Building on this, the **Biodiversity 2020 strategy for England's wildlife and ecosystem services** (Defra, 2011b) refers heavily to the recommendations in **Making Space for Nature** (Lawton and others 2010) and states how important it is to create sites that sit within a strong ecological network. It sets out that our mission is to halt overall biodiversity loss (although our ambition should be to go further than this to achieve net gain), support healthy well-functioning ecosystems and establish coherent ecological networks, with more and better places for nature for the benefit of wildlife and people.

As part of Biodiversity 2020 delivery the two outcomes specifically aimed at reducing habitat fragmentation are outcomes 1B & 1D:

- Outcome 1B: "More, bigger and less fragmented areas for wildlife, with no net loss of priority habitat and an increase in the overall extent of priority habitats by at least 200,000 ha";
- Outcome 1D: "Restoring at least 15% of degraded ecosystems as a contribution to climate change mitigation and adaptation".

The second outcome is very much aimed at the implementation of the healthy well-functioning ecosystems in the biodiversity 2020 aims, which will help deliver better ecological networks and benefit ecosystem services for people.

Another relevant policy document is the **Government National Planning Policy Framework** (DCLG, 2012) which includes specific policies on conserving and enhancing the natural environment through planning. It states that:

- The planning system should contribute to and enhance the natural and local environment by minimizing impacts on biodiversity and providing net gains in biodiversity where possible, contributing to the Government's commitment to halt the overall decline in biodiversity, including by establishing coherent ecological networks that are more resilient to current and future pressures (policy 109);
- Local planning authorities should set out a strategic approach in their Local Plans, planning positively for the creation, protection, enhancement and management of networks of biodiversity and green infrastructure (policy 114); and
- To minimise impacts on biodiversity and geodiversity, planning policies should identify and map components of the local ecological networks, including… wildlife corridors and stepping stones that connect them and areas identified by local partnerships for habitat restoration or creation; and, promote the preservation, restoration and re-creation of priority habitats, ecological networks and the protection and recovery of priority species populations, linked to national and local targets, and identify suitable indicators for monitoring biodiversity in the plan.

In the marine environment, the UK Government, working with the devolved administrations, is aiming to protect habitats and species by contributing to an ecologically coherent network of marine protected areas. The main types of marine protected areas in English waters are:

- European Marine Sites, comprising SACs and SPAs.

- Marine Conservation Zones and SSSIs with marine components.

Over 25% of English waters are now within marine protected areas and this figure will rise as further sites are designated. Outside of marine designated sites, an imminent Defra consultation on the **Marine Strategy Framework Directive** 'programme of measures' to achieve good environmental status should allow a discussion around this topic.

## 2.3 Addressing impacts of habitat fragmentation on Natura 2000 sites

The following sections of this plan recommend a strategic approach to addressing habitat fragmentation for the Natura 2000 network in England, using or signposting existing sources of evidence. Applying the approach recommended by this theme plan should also help to identify evidence gaps and potential barriers to delivery. The plan consists of three elements which when used in combination will enable actions to be prioritised at both a national and site based level:

- An approach for prioritising where effort should be focused nationally or regionally;
- Suggestions for the development of priority management actions for inclusion in site based plans; and
- Suggestions of priority actions.

# 3. From theory to practice

## 3.1 The principles

The main options available for establishing coherent and resilient ecological networks and for 'defragmenting' landscapes are neatly conceptualised by the principles summarised in the Making Space for Nature report as 'more, bigger, better and joined' conservation areas (Lawton, 2010).

The report made clear that we need to:

i) Improve the quality of existing sites by better habitat management and reduced pressures.
ii) Increase the size of existing wildlife sites.
iii) Enhance connections between sites, either through physical corridors or 'stepping stones'.
iv) Create new sites.
v) Reduce the pressures on wildlife by improving the wider environment, including through buffering wildlife sites.

When applying these general principles to management on the ground, a range of management options can be taken. This is illustrated in Figure 6, which specifically refers to woodlands but covers principles that are relevant to most natural systems.

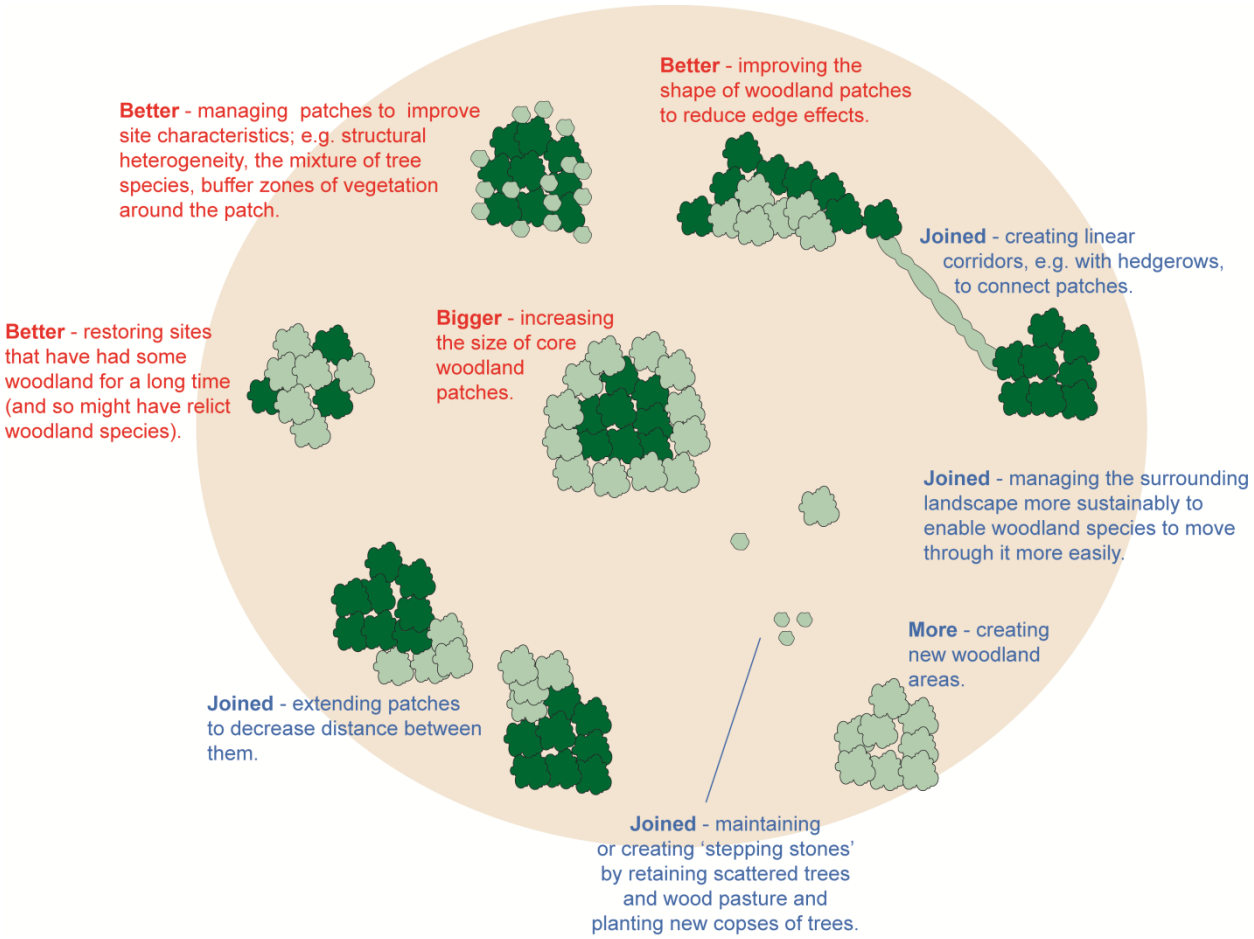



**Figure 6. Conceptual diagram of options to establish coherent ecological networks in forests and woodlands.** Developed as part of the Woodland Creation and Ecological Networks (WrEN) project (University of Stirling, 2014).

The relative importance of different site and landscape features (and therefore the priority of different management options) varies between species. For example, a recent literature review of studies of how species in

temperate forests and woodlands respond to different ecological network features (Humphrey and others, 2014) found that the characteristics of a patch are important across all taxonomic groups. The relative importance of other features, based on the proportion of studies reporting a significant effect, appears to vary across taxa: for vascular plants, the most important features were proximity to other patches, and to a lesser extent ecological continuity of the patch; for vertebrates, patch area and the intervening matrix; for invertebrates, the amount of surrounding habitat (Table 1). A collaborative research project between University of Stirling, Forest Research and Natural England is currently investigating this in more detail in the field (Macgregor and others, 2014, University of Stirling, 2014).

**Table 1. Summary of the influence of local (site/patch/stand) and landscape components on species in temperate forest/woodland, based on a review of literature.** Plus signs indicate a large proportion of published studies reporting a positive effect of a particular variable on species richness, occurrence and/or abundance of a particular group.

| | Lichens, bryophytes, fungi | Vascular plants | Invertebrates | Vertebrates |
|---|---|---|---|---|
| Patch characteristics | +++ | ++ | ++ | ++ |
| Patch area | | | | ++ |
| Proximity to other patches | | ++ | | |
| Patch age | | + | | |
| Amount of surrounding woodland | | | ++ | |
| Matrix (eg stepping stones, corridors) | | | | ++ |

Recent research studying the importance of different ecological network components for grassland invertebrates found that the floristic diversity of individual patches, the proximity of patches to species-rich grassland, and the amount of intensive agriculture in the surrounding landscape were the major factors correlated with abundance of all species groups (Woodcock and others, in press).

Another study (ADAS and others, 2013) considered the role of agri-environment schemes in creating and maintaining ecological networks. The study included a review of literature on topics such as metapopulation theory and connectivity, the conclusions from which were that "*increasing patch quality (in other words the availability of resources within a patch) is more important than increasing patch size, which in turn is more important than increasing between patch connectivity. However, increasing any of these three will always be beneficial to (meta)population persistence*".

A study of long term population trends in woodland birds (Newson and others, 2014) investigated how the habitat attributes of a site and the surrounding landscape might protect local populations from high mortality during extreme winter weather events and aid their recovery. The results highlighted the importance of habitat fragmentation and the size of woodland patches, but showed that woodland generalists and specialists responded

differently. Populations of woodland generalist species were most sensitive to winter weather if they were located within fragmented landscapes, with large distances between woodland patches. Populations of woodland specialists were more likely to recover faster from a population reduction after an extreme weather event if they were within a large woodland patch. The findings suggest that measures to increase landscape connectivity may be most likely to benefit woodland generalists, while increasing the size of woodland patches may be most likely to benefit woodland specialists. Since patch size and landscape connectivity are intrinsically linked in real landscapes, habitat protection and creation to maximise patch size and reduce the distance between patches would be likely to benefit the widest range of bird species.

A study of the responses to forest fragmentation of macro-moth species in southern England (Slade and others, 2013) found that mobile forest specialists appeared to be most affected, and the results suggested that forest patches of at least 5ha with interior forest more than 100m from the edge are needed to support populations of forest specialist moths. The study also highlighted the role of small patches and scattered trees as 'stepping stones'.

In summary, it is clear is that the quality of individual patches (ie making sure that they provide habitat for the species of interest) is crucial. Beyond that, different management actions will have varying benefits for different taxonomic groups, but making bigger and/or more closely aggregated patches of semi-natural land cover seems to benefit a wide range of species and this should be a priority whenever opportunities arise.

Ideally, site managers should consider options in detail for their areas, taking into consideration the requirements of the particular species and ecosystems they are interested in.

## 3.2 Analytical tools

A number of detailed analytical tools are being developed to help identify priorities for management to enhance ecological networks. Case studies from three of these are presented here, the Natural England National Biodiversity Climate Change Vulnerability Assessment (NBCCVA), Liverpool University's Condatis software, and Forest Research's Integrated Habitat Network model. Natural England and its partners are currently undertaking work to compare these tools and modelling approaches. This will help us to understand better the strengths and limitations of each model and how they can best be used, separately or in combination, by conservation practitioners.

Particularly at the national scale, but often at a regional or local scale too, all tools / assessments are usually based on the same datasets and so will be subject to the same issues relating to scale and how representative the data are of the features of interest. There is a need for a dataset of sensitivity of Natura 2000 features to which fragmentation analysis can be applied. This would be a significant task, requiring all designated habitats / sub-communities and species to be assessed.

### National Biodiversity Climate Change Vulnerability Assessment (NBCCVA)

Natural England has developed a model that facilitates the assessment of a range of issues that contribute to the vulnerability of areas of habitat to climate change, such as habitat fragmentation, based on widely accepted principles of climate change adaptation for biodiversity. It provides a high level indication of the relative vulnerability of priority habitats to climate change in different places, identifying why areas are vulnerable and which possible interventions, such as habitat creation to reduce fragmentation, can have the biggest impact in increasing resilience in a changing climate. The approach aims to provide:

- a spatially explicit assessment of the relative vulnerability of priority habitats and the metrics that contribute to this, based on established climate change adaptation principles at a national scale;
- a suite of map-based GIS outputs at a variety of scales, which can be analysed (in conjunction with other relevant spatial data) to target action to build biodiversity resilience; and

- a flexible, GIS based, decision support tool that allows the user to incorporate locally specific datasets and select how adaptation principles are combined to reflect local circumstances and priorities.

The methodology uses a GIS-based 200m x 200m grid at a national scale to assess areas of priority habitat for their:

- Intrinsic **sensitivity** to climate change; the model assigns high, medium or low sensitivity to direct climate change impacts – reflecting the habitat itself on the basis of expert judgement and scientific literature.
- Adaptive capacity; a range of different local factors can increase or decrease the ability of the habitat to adapt to climate change – to reflect this the model includes measures of **habitat fragmentation**, **topographic variation** and **management and condition**.

The individual metrics can be used to highlight specific issues, such as habitat fragmentation, and the elements can be added together to produce an overall assessment of vulnerability. Key outputs are data and maps showing the results for the metrics and the range of relative scores across the country, giving a visual representation of the assessment metrics and the most vulnerable areas. The example in Figure 7 shows the habitat fragmentation metric used in Section 4 of this plan, for an example location on the South Coast of England.

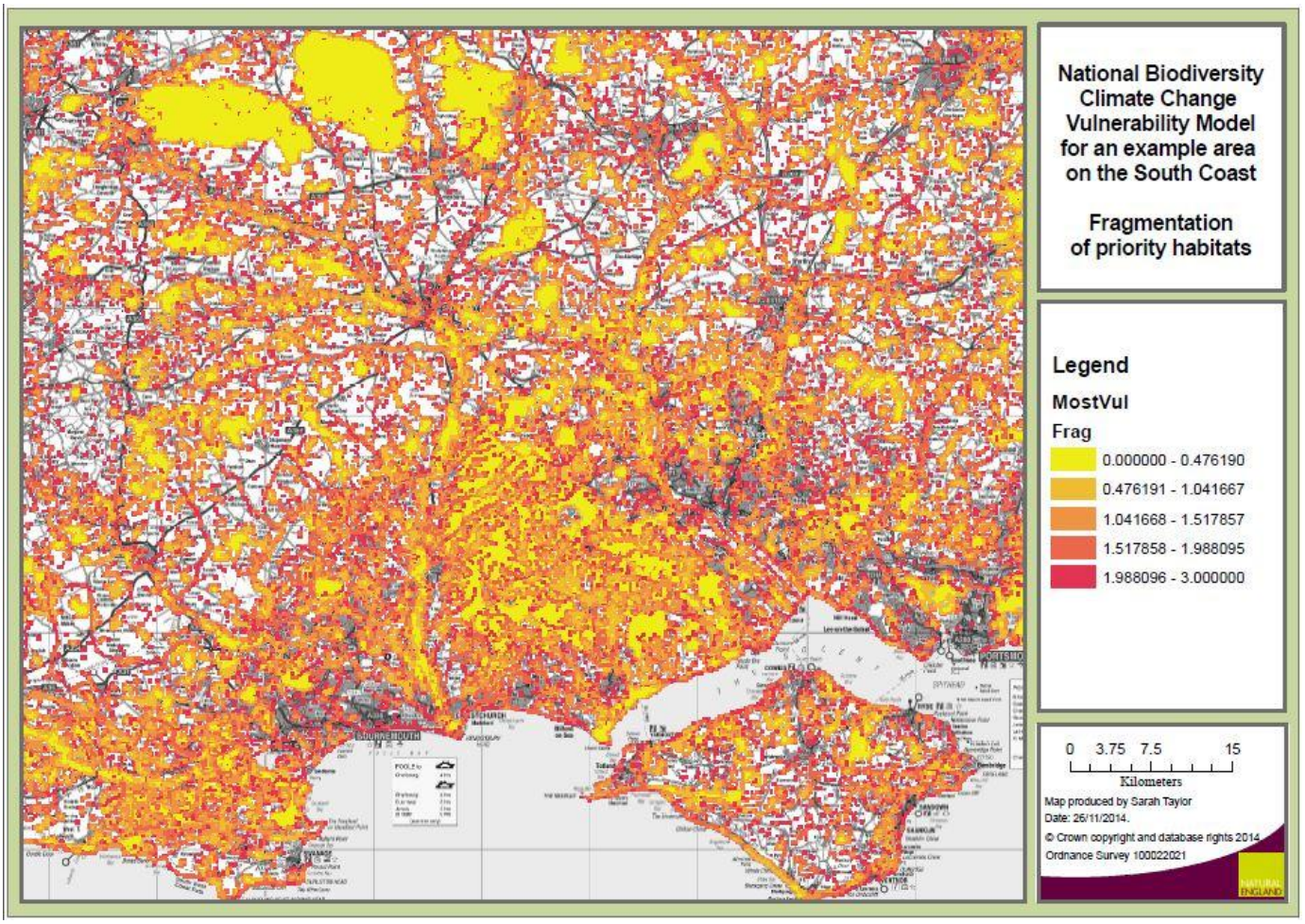



**Figure 7. Illustration of NBCCVA mapped habitat fragmentation output for an example area on the South Coast**

The NBCCVA enables the re-running of assessments of vulnerability, facilitates easy data updates and allows changes to the weightings of the metrics used within the assessment and the testing of habitat creation and management scenarios.

The data from the habitat fragmentation metric within the NBCCVA has been used in this theme plan to give information on the fragmentation of priority habitats within Natura 2000 sites. Detail of how it has been used in the IPENS project to identify Natura 2000 sites where action to improve habitat connectivity should be targeted is

provided in Sections 4.2 – 4.5. Further information on the NBCCVA can be found in Taylor and others (2014).

### Condatis - Buglife B-Lines case study

Condatis (Wallis & Hodgson, 2015) is a user-friendly software application developed at the University of Liverpool under a partnership project funded by NERC and with the involvement and support of the devolved UK conservation agencies, Forest Research, RSPB, Buglife and the Wildlife Trusts. The aim of the project is to implement novel methods to help with planning habitat restoration.

The methods underlying the software are based on research by Jenny Hodgson (2011; 2012) which shows that (i) the spatial arrangement of restored habitat can make a big difference to the speed at which species are able to shift their ranges, and (ii) that there is a potential trade-off between population viability within a landscape and speed with which populations can shift between landscapes. It also suggests that a landscape with sufficient habitat, adequately arranged, could be effectively 'permeable' in all directions, and thus could achieve conservation goals despite uncertainty about how species might respond under climate change.

The key features of Condatis are to:

- Calculate range shifting connectivity: that is how quickly a species could spread through and populate a landscape, over multiple generations, from one end to the other or between defined source and target locations.
- Show which of the existing habitat cells contribute most to range shifting connectivity.
- Show where the most serious bottlenecks are between a source and a target location.
- Analyse a map of potential restoration areas and rank them in terms of their ability to enhance the existing habitat network.
- Calculate metapopulation capacity, which shows which existing habitat areas are most robust to chance extinctions.

An early example of the application of Condatis has been in the Buglife B-Lines project (Robins, Evans & Hodgson, 2014), which aims to identify linear pathways across the UK, along which a series of wildflower-rich habitat stepping stones will be restored and created. These enhanced linear pathways aim to help pollinator movement across the landscape, improving habitat connectivity and contributing to more resilient pollinator populations.

Condatis was first used to assess the overlap of calculated flow of species through the landscape with the proposed B-Line routes. These had been modelled initially by creating linear 3km wide pathways between core habitat areas. The results supported the chosen B-lines routes by identifying them as areas with the greatest potential for species movement (see Figure 8).

Using the 'backwards optimisation' routine in Condatis, it was then possible to look at connectivity within the mapped B-Lines. By focussing on the B-Lines where restoration was proposed, Condatis enabled the team to calculate the contribution that each 1km cell would add to the overall connectivity of the habitat network when key habitats are created within them. This effectively prioritises the individual 1km cells which would best enhance the connectivity of the B-Lines should key wildflower-rich habitats be created. It was possible to show that by targeting a relatively small percentage of the B-Line for habitat creation, disproportionate enhancements in connectivity can be gained, thus providing a useful cost-benefit tool to maximise the connectivity gains within an area.

Once the modelling and mapping phases of work have been completed, Buglife is planning to develop the B-Lines pathways to help populations disperse more easily across large distances. Condatis outputs will help guide Buglife's project development and action on the ground, to focus effort on areas where the greatest improvements can be achieved for the least effort.

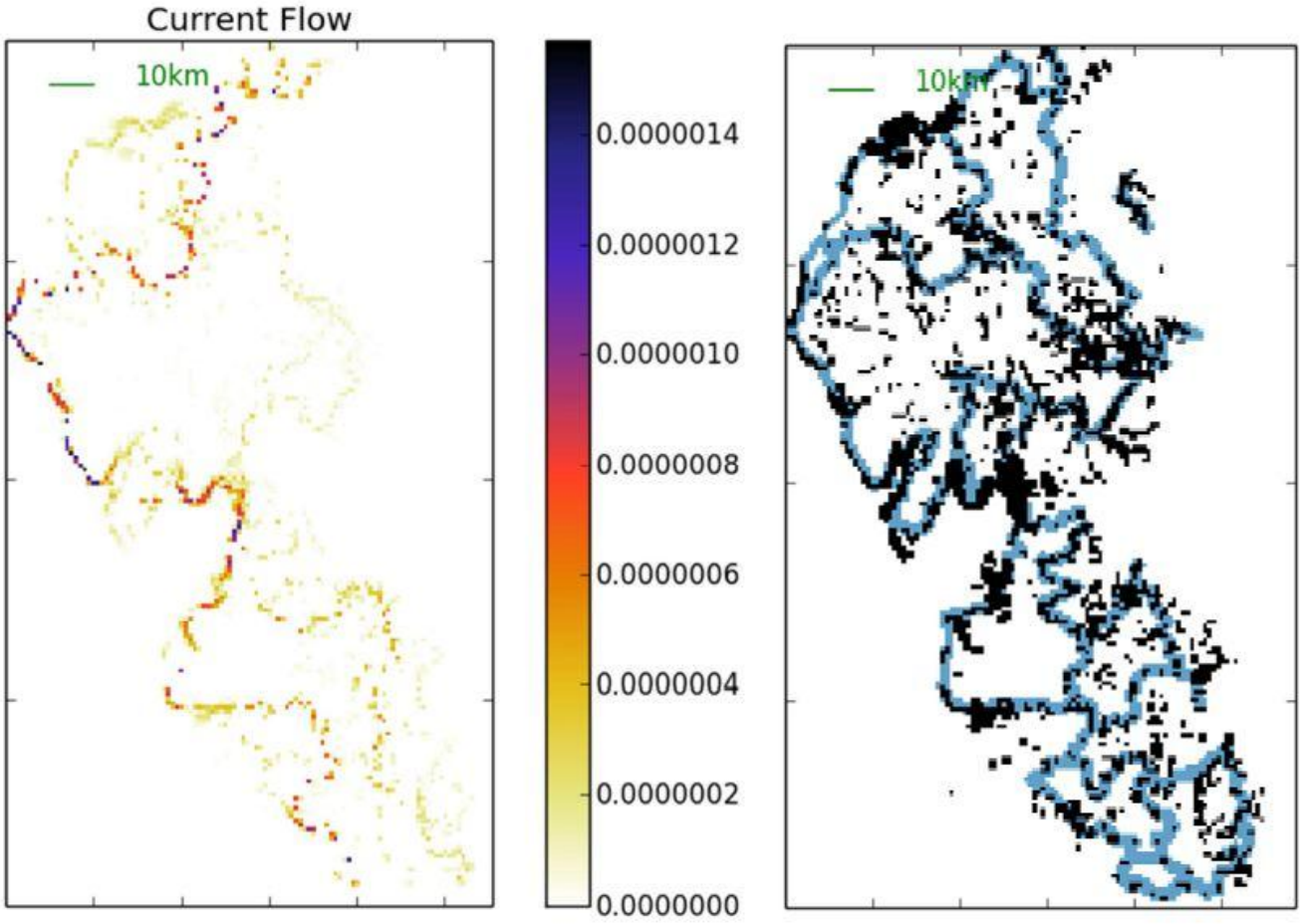



**Figure 8. (Left) Species flow through the landscape as predicted by Condatis software when applied to the B-Lines Habitat Area map. (Right) The B-Lines habitat area base map (black) overlain with the proposed B-Lines network map (blue).**

### Least-cost Ecological Network Modelling – Somerset Wildlife Trust case study

Least-cost ecological network modelling (Watts and others, 2010) is part of the BEETLE (Biological and Environmental Evaluation Tools for Landscape Ecology) suite of GIS (geographic information system) tools developed by Forest Research which follows the Integrated Habitat Networks modelling approach (Watts and others, 2005). BEETLE model analysis has already been used in a variety of projects such as developing forest habitat networks across Scotland (eg Moseley and others, 2008; Smith and others, 2008).

The BEETLE least-cost ecological network model represents functional connectivity (ie movement of species) in the landscape by considering the varying degrees to which different land cover types may limit or facilitate the movement of species. It identifies the position of habitat patches in the landscape and represents the connections between those patches as ecological networks.

The model is based on two sets of parameters; one relating to the landscape and another relating to the species moving through that landscape. The parameters can be set according to the species and habitat for which networks are being modelled.

Landscape parameters:

- Home Habitat – Ideal habitat types that will be selected from the landscape by the least-cost ecological network model. These could be species-rich habitats, section 41 habitats or areas where particular species of interest have been recorded.

- Permeability Cost – Every land cover type in the landscape is given a permeability cost which corresponds to the degree to which it impedes movement of the model species. This is based on the structural similarity of the land cover type to the ideal habitat of the model species. Land cover with a similar structure to the ideal habitat has a low permeability cost.

Species parameters:

- Minimum Viable Area - The smallest area of ideal "home" habitat that is likely to support a sustainable population of the model species.
- Maximum Dispersal Distance - The distance that the model species is able to move through its ideal habitat.

Using this approach it is possible to assess fragmented landscapes for a range of focal species, based upon habitat availability, the number and size of networks, and the size and distribution of habitat patches within them. The outputs can identify key areas for restoration and expansion to link habitats, helping to prioritise conservation effort and preventing further fragmentation (Figure 9).

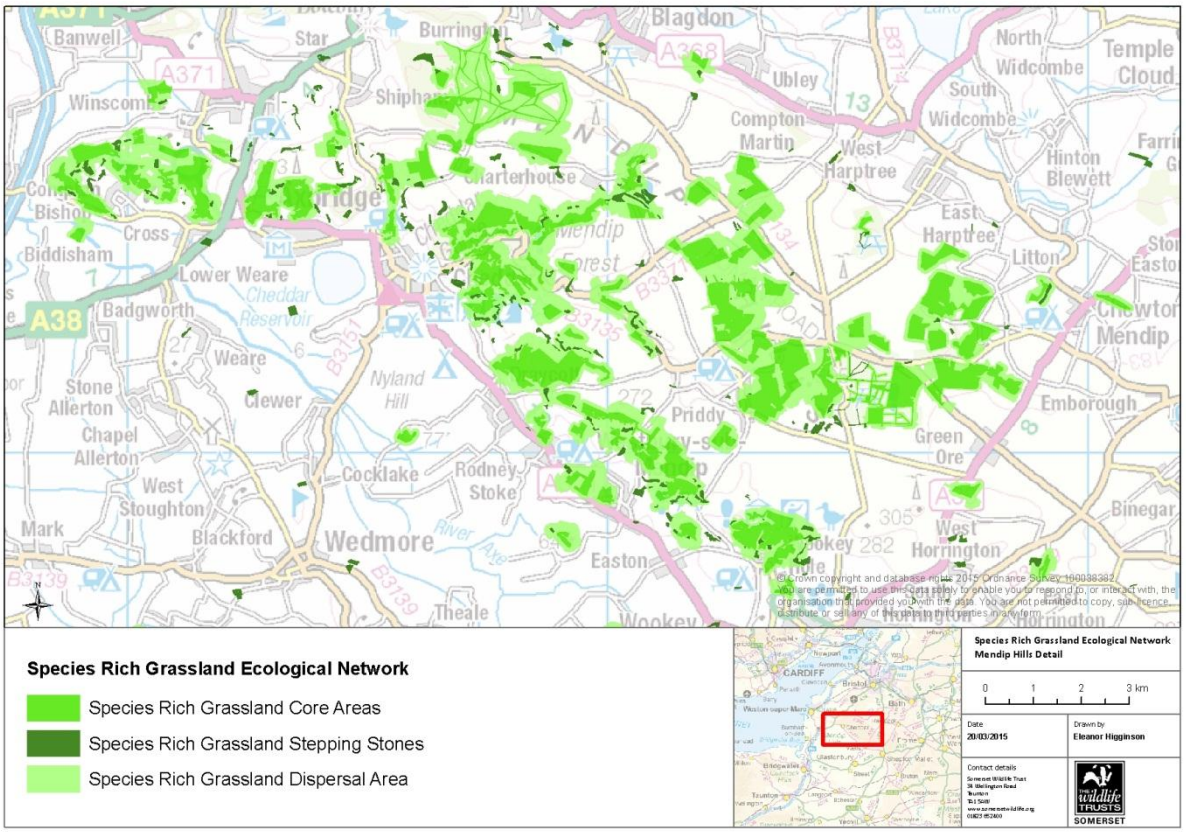



**Figure 9. Output produced by the BEETLE least-cost ecological network model for the species rich grassland network in the Mendip Hills, Somerset.**

The components of the ecological network shown in Figure 9 are:

- Core Areas - Patches of the home habitat that are at least as big as the "minimum viable area". This means that the patches of habitat are big enough to support a viable population of the generic focal species for that habitat. These sites will act as a source of individuals moving out into the landscape.
- Stepping stones - Areas of home habitat that are smaller than the "minimum viable area" but provide important intermediary areas of habitat and add to the diversity of the landscape as a whole.
- Dispersal Area – A flexible buffer that represents where species are able to move to in the landscape. The size of this area is a function of the maximum distance the model species can disperse and the permeability of the

landscape. Therefore it can contract or be extended according to land cover type. Patches of habitat that occur within the same dispersal area are considered to be in the same ecological network.

The least-cost ecological network modelling approach has been applied by Somerset Wildlife Trust in partnership with Somerset County Council to represent the ecological networks in Somerset for four broad habitat types; Species-rich Grassland; Broadleaved Woodland; Fen, Marsh and Swamp; and Heathland and Acid Grassland.

A continuous land cover map for Somerset was produced based on Ordnance Survey Master Map data and formed the landscape element of the model. Land cover types were derived from multiple data sets ranging in detail from field survey to aerial photo interpretation. Each land cover type was assigned a permeability score based on Eycott and others (2011) which would determine how far the focal species could move through that parcel of land.

The model species used in Somerset were generic species with characteristics based on the dispersal capabilities and habitat area requirements of important species found in the county. A different generic species was developed for each of the broad habitat types modelled. The parameters used represented species with a moderate sensitivity to habitat fragmentation and were validated against the size of habitat patches existing in the county. This ensured that the networks produced were relevant to the Somerset landscape and did not present a restricted or overly optimistic view of ecological networks in the county.

Following the modelling of ecological networks in Somerset, Somerset Wildlife Trust commissioned Forest Research to devise a simple, repeatable method for evaluating ecological networks using GIS. This led to the production of the CORE (COherence and REsilience) toolbox which allows the coherence and resilience of ecological networks to be assessed according to the principles of bigger, better, more and joined. The CORE toolbox can be used to identify specific actions that can be implemented on particular habitats which will enhance the ecological networks at the landscape scale.

The ecological networks produced in Somerset are contributing to landscape scale conservation decision making across the county and have been adopted by the Somerset Local Nature Partnership. Somerset's ecological networks are included in the Somerset Minerals Plan together with supporting policies to guide landscape-scale restoration and after use of aggregates extraction areas. They are currently being shared with other Local Planning Authorities in Somerset to allow the impact of development on ecological networks to be assessed and to identify opportunities for improving ecological networks, as is required in the National Planning Policy Framework.

## 3.3 Large-scale conservation initiatives

There are hundreds of large-scale conservation initiatives across England, the majority of which are aiming, among other things, to create more coherent and connected natural landscapes (Macgregor and others, 2012; Eigenbrod and others, in press). The largest national programmes include Nature Improvement Areas, the RSPB's Futurescapes, the Wildlife Trusts' Living Landscapes and Butterfly Conservation's Landscape Target Areas, each of which contains many separate initiatives. There are also many stand-alone projects.

Natura 2000 sites are an important component of many existing large-scale conservation initiatives. The designated sites with surrounding priority habitat provide crucial 'core areas' from which species might be able to spread into restored areas, while the conservation work in the surrounding landscapes offers an opportunity to link and buffer sites and soften the matrix between them. Figure 10 shows how some of the major large-scale conservation programmes intersect spatially with Natura 2000 sites and Table 2 shows the degree of overlap between these initiatives and the Natura 2000 network in England.

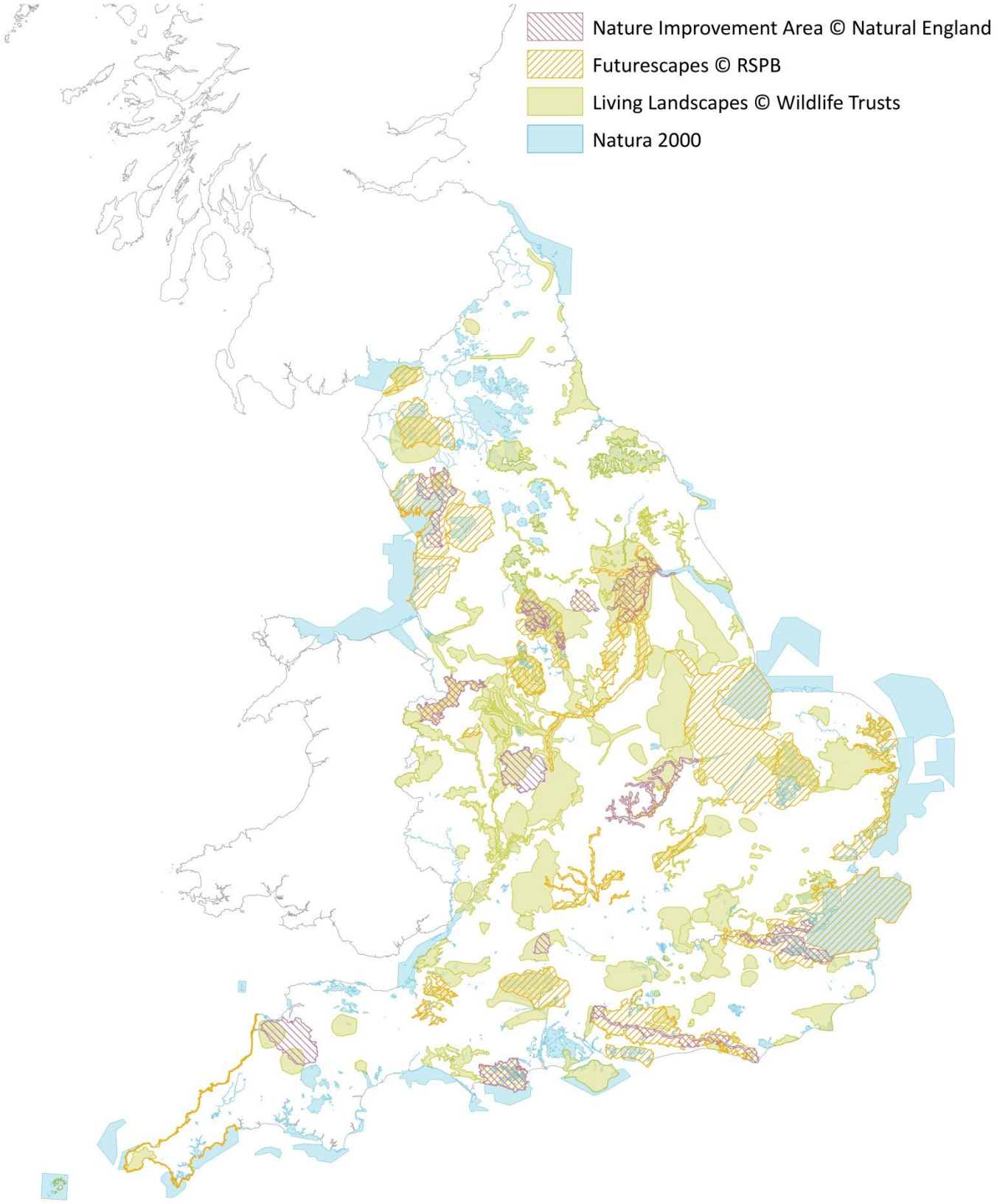



**Figure 10. Spatial arrangement of key landscape scale conservation initiatives in relation to Natura 2000 sites**

**Table 2. Coverage of the Natura 2000 network in England by selected landscape scale conservation initiatives** (based on data presented in Figure 10)

| | Total area (ha) | Area which is Natura 2000 (ha) | % of the Natura 2000 network in England |
|---|---|---|---|
| Living Landscapes | 3,086,559 | 303,154 | 14.4 |
| Nature Improvement Areas | 501,306 | 68,055 | 3.2 |
| Futurescapes | 2,271,363 | 611,862 | 29.0 |
| Total area with at least one initiative | 4,688,856 | 768,651 | 36.6 |

### Nature Improvement Areas

A major theme of the Natural Environment White Paper is the need for joined up and resilient ecological networks at a landscape scale. One of the most tangible outcomes from this was the establishment of 'Nature Improvement Areas'. Defra funded 12 pilot Nature Improvement Areas (NIAs) from 2012 to 2015 to develop the concept further. (https://www.gov.uk/government/publications/nature-improvement-areas-improved-ecological-networks/nature-improvement-areas-about-the-programme). A fundamental component of the NIA competition in 2011 was that each prospective partnership had to address the longer term ambition to 2020. So, now the twelve partnerships are continuing having secured resources to enable the good work started April 2012 to continue.

NIAs are relatively large, discrete areas where local partnerships of government agencies, local authorities, conservation bodies, community groups and business interests have collaborated to develop a shared vision for their natural environment. During the pilot, the NIAs have developed significantly and have started to deliver against the requirement of enhanced ecological connectivity. Each NIA has addressed connectivity from a local perspective blending national guidance and mapping with local data, knowledge and opportunities to create and enhance coherent ecological networks within their areas. Innovative approaches are being tried out, where the practical use of science is still developing (Collingwood Environmental Planning, 2014). This includes the development of an Integrated Habitat Network tool by Forest Research for the Dearne Valley Green Heart NIA, which is mapping potential habitat networks using least-cost modelling (URL: http://www.barnsleybiodiversity.org.uk/nia.html), and a 'functional wetland ecosystems' approach for the Meres and Mosses NIA (see case study below).

The National Biodiversity Climate Change Vulnerability Assessment (NBCCVA) data, introduced in section 3.2 above and used within this project (see sections 4.2 – 4.5), was provided to all the NIAs at a series of workshops to discuss approaches to climate change adaptation (van Dijk and others, 2013). The data has contributed to work on ecological network projects in the Greater Thames Marshes NIA, Wild Purbeck NIA and the Morecambe Bay NIA. This led to a collaborative project on ecological networks in Morecambe Bay NIA which aims to explore and better understand the results of spatial data that contributes to ecological network design and implementation using the NBCCVA data alongside other data at both local and national scales.

In total, actions to restore / create and maintain / improve priority habitat have been completed, are ongoing or are planned on 24,200ha, or 4.7%, of the total area of the 12 initial NIAs. The habitat creation and restoration works within the NIAs are helping to improve habitat connectivity, addressing the objectives of 'more, bigger, better, joined'. The increase in connectivity is difficult to quantify, but research and reporting commissioned by NIA partnerships has added to the understanding of how to improve connectivity and measure change

(Collingwood Environmental Planning, 2014).

Progress reports from the initial pilot period for the 12 national NIAs are available at the website listed above. In addition, Local Nature Partnerships / Biodiversity Partnerships (LNPs / BPs) and local planning authorities can identify and agree where locally determined NIAs can be set up, although the current economic climate may be constraining where this is happening in practice. Locally determined NIAs are encouraged to apply the same criteria, monitoring and evaluation framework and lessons learnt from the 12 initial NIAs to assist their development and progress. Guidance is available which provides further information for locally determined NIAs (URL: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/69600/pb13824-nia-criteria.pdf).

**Meres and Mosses NIA – Functional ecological units approach (based on Jones, 2014)**

The Meres & Mosses is a unique landscape that stretches from mid Shropshire north through Cheshire, and from the Welsh borders east into Staffordshire. It is a post-glacial wetland landscape, created at the end of the last Ice Age over 10,000 years ago. The most important features are the meres, deeper areas that survive even today as open waterbodies; and the mosses, shallower areas where successional processes resulted in the development of lowland raised bogs and associated peat-based wetlands. It is a landscape of international importance, although one in which ideas around habitat connectivity and substantial re-creation need to be applied slightly differently from some other wetland systems, as the physical extent of the meres and mosses is largely determined by a specific combination of topography and geology, which has resulted in naturally separate wetlands.

Creating a coherent and resilient ecological network in the Meres & Mosses is crucial. To do this, a new and more ambitious approach to conservation is required, one that is based on conserving and improving the ecosystems that underpin the landscape. At the centre of the ideas the NIA is proposing is a re-definition of 'sites', going beyond simply delineating remaining habitat and protected sites to identifying and protecting 'functional ecological units', defined on the basis of topography, hydrology, and the peat soil resource. They should comprise two elements:-

- A core area of high quality wetland habitat mosaic – not just a mere or moss, but also the full range of associated wetland habitats that might be expected or can be restored around the central feature. These areas should be as large as possible, with stable hydrology to allow natural processes to be sustained.
- This 'core' then needs to be contextualised within the landscape, primarily relating to the catchment that feeds the wetland mosaic. Intensive agricultural land use between the Meres and Mosses needs to be managed to ensure that the core areas are adequately safeguarded, and the impact of surrounding land use, particularly in terms of water quality, is mitigated.

A comprehensive mapping exercise has been undertaken to show what the concept looks like on the ground. A consequence of 'functional ecological units' is that the conservation sector's targets and aspirations will need to be up-graded to reflect the new ambition. These will need to reflect the enhanced size and quality of sites, how these sites will interact to deliver an effective ecological network, and what is required of the wider catchment. This in turn requires clearer visualisation of what this might look like, and consideration over timescales measured in decades rather than years. Where on-going management intervention is required, greater emphasis needs to be given to its quality and the ability for it to be sustained, potentially requiring the use of more novel techniques to cost-effectively achieve desired outcomes.

### Futurescapes

Futurescapes is the RSPB's UK-wide programme of landscape scale conservation initiatives. It is funded by the EU LIFE Nature programme. RSPB has a vision to achieve a step-change in sustainable countryside management through working in partnership with environmental organisations, local communities, businesses and government bodies. Futurescapes is advocating a 'landscape' approach to conservation, to learn how to make the best use of our land to delivery multiple objectives, including agriculture, forestry, housing and conservation.

A series of priority landscapes (25 in England) have been identified and the RSPB is seeking to engage with landowners in those areas to identify how countryside management can be optimised to make nature reserves and protected areas the best they can be for nature, and also to connect up fragmented habitats between them.

Further information is available at: URL: http://www.rspb.org.uk/whatwedo/futurescapes/index.aspx

### Living Landscapes

Since 2006, the Wildlife Trusts have been working at a landscape scale, helping to create a resilient and healthy environment that is rich in wildlife and provides ecological security for people, through their 'A Living Landscape' programme. There are now over 100 Living Landscapes schemes where Wildlife Trusts are working to restore, recreate and reconnect wildlife rich habitats in rural and urban areas, working in partnership with communities, landowners, schools and businesses.

Further information is available at: URL: http://www.wildlifetrusts.org/living-landscape

### Wetland Vision

The Wetland Vision is a project which sets out a 50 year vision for England's freshwater wetlands. It aims to describe the location, nature and extent of the wetland landscape that will be needed in the future, illustrated through maps. This forms the basis of a shared approach and, together with support for local action, will ensure that wetlands remain a valuable component of the landscape. The conservation, rehabilitation, and creation of new wetland ecosystems will be a vital part of strategies for adapting to climate change. The Wetland Vision project partners are English Heritage, Environment Agency, Natural England, RSPB and the Wildlife Trusts, although they intend to work with a much wider network of partner organisations to turn the vision into a reality.

Further information is available at: URL: http://www.wetlandvision.org.uk/dyndisplay.aspx?d=home

### Social and institutional aspects of large-scale conservation

The large-scale action that is often required to reverse habitat fragmentation generally requires working in partnership, and often across land holdings. Therefore the human dimension is a vital part of the planning and management process. As Elliot and others (2011) pointed out, much large-scale conservation is "novel and challenging in terms of institutions as well as ecology".

Fundamental to the delivery of an ecological network and therefore providing expanded support for species, is to develop social networks that work across land ownership and administrative boundaries. Lawton (2010) recognised the complimentary roles of economic, environmental and social capital in achieving change. Building trusting relationships with the landowners and farmers adjacent to important conservation sites helps to establish the social networks that are essential to establish coherent and resilient ecological networks and maintain them in the long term. The Lawton report specifically mentions a range of economic (eg tax incentives) and social (eg rewards for cooperation) mechanisms to change the behaviour of target farmers. Failure to consider the socio-economic aspects of habitat fragmentation risks jeopardising the final outcomes.

A forthcoming Natural England report on large-scale conservation (Eigenbrod and others, in press) contains a detailed chapter on social and institutional aspects.

## 3.4 Mechanisms and funding opportunities

### Available mechanisms

'Mechanisms' are being defined by the IPENS project as the enabling structures for the implementation of actions, and therefore include a range of possibilities. These include agri-environment schemes (Countryside Stewardship), legislative requirements (eg requirements under Article 6(4) of the Habitats Directive 1992 to create 'compensation habitat' to offset the impacts of certain developments) and partnership projects (Futurescapes, NIAs etc.). Many of these are available for use, and in practice a combination of several mechanisms may give the best opportunity to successfully deliver a programme of work.

A key management mechanism to secure and fund habitat creation and other actions to improve habitat connectivity on protected sites and in the wider countryside is the new Rural Development Programme agri-environment scheme, Countryside Stewardship. The following section describes this in more detail.

### Rural Development Programme Countryside Stewardship

Agreements under the new Rural Development Programme (RDP) Countryside Stewardship environmental land management scheme, Countryside Stewardship, will start in 2016. As in previous schemes, participation by land owners will be voluntary. The main priority of Countryside Stewardship is biodiversity, with water quality another important priority. There are prescriptions within the scheme that will also help to improve:

- flood management
- the historic environment
- landscape character
- genetic conservation
- educational access
- climate change adaptation and mitigation

It will be more targeted and focused than previous schemes. This will encourage applicants to enter into agreements which deliver the right environmental management in the correct combinations and in the right places. It should also help to ensure that Countryside Stewardship yields multiple benefits and is good value for taxpayers' money.

Together with ongoing Environmental Stewardship (ES) and England Woodland Grant Scheme (EWGS) agreements, Countryside Stewardship will be an important way of helping farmers and land managers deliver against a wide range of local, national and international environmental commitments. It must be noted though that financial constraints mean that this scheme will not be able to deliver all the improvements that are required.

The new scheme should help:

- Wildlife and nature: by enabling landowners to restore and connect habitats.
- Pollinators: by incentivising the management and creation of habitat that provides pollen and nectar sources and nesting places.
- Forestry and woodlands: by funding the planting of new trees and supporting the management of woodlands.
- Water/flooding – helping landowners to fund measures that will make water cleaner and reduce flood risk by supporting changes to farming practice (such as remediating soil compaction and crop management), improving farm infrastructure and creating woodland.

Where possible, scheme advisors will work with landowners to develop schemes that will offer the best opportunities to achieve benefits for biodiversity, water quality and flood management together.

Countryside Stewardship will be available to all eligible farmers, land managers, land owners and tenants in England. The scheme guidance has been published which explains who is eligible to apply (URL:

https://www.gov.uk/government/collections/common-agricultural-policy-reform). Countryside Stewardship will have three main elements:

- Higher Tier (similar to Higher Level Stewardship)
- Mid-Tier (similar to Entry Level Stewardship)
- a lower tier of capital grants, including the Hedgerows and Boundaries Capital Grants

Importantly, 'facilitation funding' will be available to organisations working with groups of farmers to deliver Countryside Stewardship priorities on a large scale across landscapes. This could have a lot of potential to deliver benefits for protected sites, especially wetlands and rivers and for measures to enhance connectivity.

The tiers give access to funding and/or capital grants for a range of environmental management actions ('options'). Defra has also published the proposed payment rates for land management options and capital items (see the URL above).

Countryside Stewardship is adopting two complementary approaches to ensure delivery for species as well as habitats. These are:

a. The Mosaic Approach – There will be a much greater emphasis on creating mosaics within habitats that include the important elements that are required by species, eg bare ground, scrub, varying sward structures. By managing habitats in this way and embracing heterogeneity in habitat structure, the majority of species (whose ecological needs/limiting factors can be addressed through generic 'best practice' habitat management) will be catered for.

b. The Bespoke Approach - It is recognised that for certain species or assemblage of species, for example the marsh fritillary butterfly, tailored management will be needed to deliver their specific habitat requirements. Such an approach caters for species whose ecological requirements/limiting factors, at the option, agreement or landscape scale, cannot be fully addressed through more generic habitat management described above. This is because the species may require certain aspects to ensure successful conservation, for example:

    - Option-level management of a habitat that goes beyond that prescribed under the mosaic approach (eg higher proportion of bare ground needed for stone curlews, bespoke seed mix etc.).
    - A higher level of pre-agreement advice, within-agreement aftercare, or monitoring to inform successful delivery of the desired environmental outcomes (ie adaptive management) is required (eg wet grassland breeding wader assemblage, specific management for Greater Horseshoe Bat or Duke of Burgundy butterfly).

### Gaps and shortfalls in current mechanisms

Despite the range of mechanisms already available to improve habitat connectivity, their inherent limitations often mean that it is difficult to secure appropriate improvements in the locations where they are most needed. Countryside Stewardship has three significant weaknesses, which will limit its potential to address habitat fragmentation if not applied in conjunction with other delivery and funding mechanisms:

i) uptake of the scheme by landowners / farmers is voluntary, so it may not be possible to secure required improvements to habitat connectivity where they are most needed;

ii) the overall budget is too low to fund all the required changes to meet the objectives of the Habitats Directive, Birds Directive, Water Framework Directive and Biodiversity2020. This needs to influence the next round of Common Agricultural Policy reform, such that agricultural support works effectively to support the objectives of European Directives and the benefits that can be gained from climate change adaptation etc.;

iii) most schemes will be short-term ie 5 years - unless a specific case can be made for longer (for example, 10 years for saltmarsh or wetlands in floodplains). This means it may be difficult to secure sufficient long term management.

There may be difficulties in affording protection to areas of land outside of protected sites that is not currently of nature conservation interest, but which has the potential to become buffer or 'stepping stone' habitat. For example, SSSIs can only be designated where land is of special interest for its flora, fauna, geological or physiographical features, although those features may be in an unfavourable or degraded condition at the time of designation. The *Guidelines for selection of biological SSSIs* (JNCC, 2013: see Part 1, section 5.12) describe selection on the basis of 'potential value', for instance where the inclusion of a degraded area occurs between two high-quality parts of a compound site and where its restoration might benefit all three elements of the site. However, the Guidelines do not provide for the use of SSSI designation to protect land which does not currently have any special interest, purely for the purposes of creating habitat to improve connectivity.

Another situation where there are limits to the use of site designation to protect land relates to the inclusion of buffer areas. Areas of land that support processes upon which the features of a SSSI depend (such as hydrology, sediment supply, coastal processes) may be considered to form part of the 'special interest' and be included within the SSSI. The Guidelines (JNCC, 2013: Part 1, section 8.5) describe the concept of buffer land and recommend that surrounding land should be regarded either as sufficiently important to the special interest to be included within the site, or it should not be designated. There should be a functional relationship between the 'buffer' and the 'core' area. Although there is no requirement for the buffer land to be in a pristine or favourable condition, as is the case for connecting habitat described above, there must be some existing interest. The Guidelines do not provide for the designation of land purely for the purposes of creating 'buffers' where none currently exist.

Starting with a debate about the tools that are really needed to deliver landscape scale conservation, it will be important to explore how existing mechanisms and legislative powers can be better used, and to identify new, more flexible mechanisms, that are adequately funded and long term. Natural England is currently investigating new and improved mechanisms and levers that could be used for conservation in the future, as part of developing a Conservation Strategy.

### Funding opportunities

Landscape-scale projects aiming to restore habitat connectivity typically require significant amounts of funding over many years; and securing ongoing funding is a frequent challenge (Eigenbrod and others, in press). Common funding sources for past and current large-scale conservation initiatives include:

- Lottery Funding, eg Heritage Lottery Funding (HLF), which provides large grants for advisory and heritage-related purposes with specific targets and requirements.
- Landfill funding, eg Biffa Award, SITA Trust, Waste Recycling Environmental (WREN).
- European funding eg EU LIFE, INTERREG.
- Charitable Trusts, eg Tubney Charitable Trust.
- Public grant schemes, eg agri-environment schemes under the RDPE.
- Project or species sponsorship / branding.
- Biodiversity offsetting.
- 'Self-support' funding from existing partner organisation programmes (including in-kind contributions) or raised through appeals, membership fees, campaigns etc.

In some cases there may be opportunities to partner with commercial and other organisations, such as businesses, health authorities, insurance companies, that can offer non-traditional funding routes or draw in new funding. More innovative thinking around this should be encouraged. Examples include:

- **Ouse Fen** – a partnership project between RSPB and Hanson (supplier of aggregates) to transform a working sand and gravel quarry into a vast nature reserve with open water, grassland and, when complete, the largest reedbed in the UK.
- **The Sustainable Catchment Management Programme (SCaMP)** – a project developed by United Utilities in association with the RSPB, aiming to apply an integrated approach to catchment management across all of United Utilities water catchment land in the North West, to benefit water quality, effects on flood risk and biodiversity through moorland restoration and management.
- **Upstream Thinking** – South West Water's flagship programme of environmental improvements aimed at improving water quality at source in order to reduce water treatment costs. They are working in collaboration with regional groups, including the Dartmoor National Park Authority, Westcountry Rivers Trust and Devon and Cornwall Wildlife Trusts.
- **Greener transport network** – 'Green corridors' alongside the transport network are to be enhanced as part of a £3 million pilot project drawing together Natural England, the Highways Agency, Network Rail and Nature Improvement Area (NIA) partnerships. It will ensure that these green corridors can accommodate more wildlife – especially pollinators – and enable greater movement between sites, at the same time as benefiting transport users by making critical transport infrastructure more resilient to impacts of climate change.

# 4. A strategy for England's Natura 2000 sites – Spatial prioritisation and developing connectivity plans

## 4.1 Introduction

This section sets out recommendations for a strategic approach to address habitat fragmentation which uses a common methodology across the network. It consists of a national 'spatial prioritisation' approach based on modelled data, followed by the development of 'connectivity plans' at the local level.

Data to inform the spatial prioritisation (sections 4.2 – 4.5) has been generated by Natural England nationally and is presented in Annex 4 for use by Natural England Area Team staff, working with partner organisations. It is intended that the subsequent critical appraisal of model results (section 4.6) and other work to inform the development of 'connectivity plans' (section 4.7) should be done locally by people who know the location well. The scale at which it can be applied is flexible, so it could either be used for individual Natura 2000 sites, or to inform larger scale / landscape scale conservation projects which include Natura 2000 sites. The same methodology may be applied to other protected sites such as SSSIs and local wildlife sites.

Assessing habitat fragmentation is a complex task and further work will be required to complement the approach set out here, including a means of expressing the level of risk from fragmentation as compared to other pressures and identifying success goals so that improvements to connectivity can be measured against the requirements of the Habitats Directive (see Table 5).

## 4.2 Spatial prioritisation overview

The aim of the spatial prioritisation exercise is to identify at a national scale those Natura 2000 sites where reducing habitat fragmentation is a high priority. Fragmentation both within Natura 2000 sites and in the landscape between Natura 2000 sites is considered, recognising that the large size range and spatial configuration of designated sites means that both of these factors will be relevant across the Natura 2000 network. The national prioritisation approach uses habitat fragmentation data from the National Biodiversity Climate Change Vulnerability Assessment (NBCCVA) (Taylor and others, 2014; also see section 3.2) to summarise the fragmentation of SACs and SPAs. It builds on the work illustrated in Figure 2 from the Lawton Review carried out by Roger Catchpole and enables the ranking of sites by their fragmentation scores and prioritisation of actions to improve connectivity based on a set of objective criteria.

The full NBCCVA evaluates the relative vulnerability of areas of priority habitat (as defined by the UK Biodiversity Action Plan (UK BAP) (UK Steering Group, 1994) and section 41 of the Natural Environment and Rural Communities Act 2006) to climate change based on widely accepted principles of climate change adaptation for biodiversity (Hopkins and others, 2007). The assessment undertaken for this plan has been tailored to focus on habitat fragmentation with respect to Natura 2000 sites. Priority habitats, although not directly comparable with Natura 2000 interest features, are for the purposes of this assessment considered to be an appropriate proxy dataset with which to assess Natura 2000 sites, in the absence of Natura 2000-specific data.

The habitat fragmentation metric within the NBCCVA Assessment evaluates the structural fragmentation of priority habitats, including sub-metrics that measure habitat aggregation and the landscape matrix. Fragmentation of priority habitats within Natura 2000 sites are evaluated and the method used also takes into account the proximity of 'permeable' land use types (which in this instance is the presence of semi-natural habitat). It does this

as the habitat fragmentation method assesses the semi-natural land use types in the 1km square surrounding every 200m square across the country. In the case of the data used in the Natura 2000 site assessment, which has been cut to the site boundaries, this means that the data used actually extends slightly outside of each site. This means there is a small amount of semi-natural habitat on the perimeter of each site that contributes to the scores for the site.

The analysis shown here will help guide priorities for reducing within-site fragmentation. Coupled with this, the wider fragmentation data from the NBCCVA provides a broader picture of fragmentation in the landscape within which Natura 2000 sites sit (section 4.5). A combined use of these two analyses allows the application of a considered approach at a national scale for targeting habitat creation and restoration action at sites or habitat types that are most affected by fragmentation based on model metrics. It is recognised that further work will be required to assess in detail the impact on Natura 2000 sites of fragmentation of habitats between sites. This is noted as a priority action (Table 5) and discussed in section 4.5. The Climate Change Theme Plan (see Annex 1) provides more information on how the full NBCCVA is used for the IPENS project.

## 4.3 Within-site spatial prioritisation methodology

The national assessment conducted for this theme plan uses the NBCCVA tool, operating on a 200m x 200m grid at a national scale. It is based on data referred to as the 'All priority habitats' dataset, which includes all terrestrial and coastal priority habitats in the Natural England priority habitat inventory. The method used was as follows:

**a) The assessment first identifies the fragmentation metric score for the priority habitat that is assessed as most vulnerable to climate change within each 200m grid square.** Four metrics are used to assess habitat vulnerability to climate change: habitat sensitivity to direct climate change impacts; habitat fragmentation; topographic variety; and habitat management and condition. The results are added together to give a relative assessment of overall vulnerability to climate change for each 200m square containing priority habitat. When two or more habitats are found within a 200m grid square, the most vulnerable habitat overall gives its score to that 200m square. This is used to identify the vulnerability of Natura 2000 sites in the Climate Change Theme Plan (see Annex 1) and provides the data used in this assessment for priority habitat fragmentation.

The use of these data means that the most vulnerable habitat found in each 200m square, not the most fragmented habitat, provides the data used in this assessment. It is likely that the most vulnerable habitat will often also be the most fragmented as this is a contributing metric, but there will be occasions where a more or less fragmented habitat is present in the same 200m square but is not represented. However, as many 200m squares are included in each Natura 2000 site, the spread of habitats found across that site will be represented. Additionally, as the most vulnerable habitat in each grid square is used, until more accurate data and analysis are available, it remains a useful measure for highlighting the need for further investigation and potential fragmentation action as part of a national scale strategic approach.

**b) Habitat fragmentation data for priority habitats within Natura 2000 sites were extracted from the national NBCCVA.** Specifically, this is the habitat fragmentation metric score for the most vulnerable priority habitat within each 200m grid square within each Natura 2000 site. National maps showing a visual representation of fragmentation for the Natura 2000 network are available (Annex 4) and facilitate both a comparison of scores between sites and, particularly for larger sites, a comparison of fragmentation scores in different parts of a site. More detailed site specific maps can be requested from Natural England.

**c) Results for each Natura 2000 sites were then ranked.** The scores for the fragmentation metric across all the 200m squares within each site (determined in a and b above) were averaged across each site, resulting in a single score for each Natura 2000 site. This made it possible to rank Natura 2000 sites on the basis of most to least average fragmentation score. Ranking by other methods is also possible, for example ranking sites by the score from the most fragmented square within that site, but the average score was thought to be the most useful and

straight forward approach to give a broad picture of habitat fragmentation within Natura 2000 sites including the area immediately adjacent to them.

The ranked lists were divided, to give a high priority class (the top third of sites) and a lower priority class (the bottom 2 thirds) to be used as indicators of the urgency of action needed.

**d) Separate rankings were undertaken within 'broad ecosystem' categories.** After ranking all sites by average fragmentation scores, the sites were subsequently ranked within 'broad ecosystem' categories using the same average fragmentation score. This further refinement was undertaken because it was assumed that information on the fragmentation ranking of sites within predominant ecosystem categories might be useful for site managers wanting to compare similar sites. The sites were assigned to one of six broad ecosystem categories (see below) based on either i) the predominant habitat type in the site if that habitat is a SAC interest feature or a SPA supporting habitat, or ii) where a SAC is designated for species only, the supporting habitat for that SAC species interest feature. The categories used were:

- Coastal / estuarine
- Freshwater (open water, rivers, canals and great crested newt breeding sites)
- Upland (heath, blanket bog, montane habitats, northern hay meadows)
- Lowland wetland sites (raised mire, fens, wet grassland)
- Lowland dry sites (lowland heath, grasslands and sites designated for bats and other species with predominantly improved grassland / suburban / industrial habitats)
- Woodland / Forests.

## 4.4 Results of within-site NBCCVA

*This section should be read in conjunction with Annex 4.*

The NBCCVA methodology described above produced rankings of Natura 2000 sites based on their average habitat fragmentation score. Higher ranked sites are those which are likely to need more action or more urgent action to address the impacts of fragmentation within site boundaries. The full SAC and SPA list and maps showing the ranking results are available in Annex 4. Reasons for the position of sites within the ranking need to be explored in detail during the critical appraisal stage of the assessment (see section 4.6), for example to distinguish true fragmentation from useful habitat mosaics and to determine to what extent the level of fragmentation present is likely to be a problem for species of conservation interest on the site.

### a) All sites ranking

Table 3 shows top 10 most fragmented SACs and SPAs, ranked by average habitat fragmentation score, as identified by the NBCCVA approach described above.

**Table 3. Top 10 most fragmented SACs and SPAs ranked by average habitat fragmentation score**

| | SACs | | SPAs |
|---|---|---|---|
| 1 | Ensor's Pool (freshwater) | 1 | Northumbria Coast (coastal/estuarine) |
| 2 | Crookhill Brick Pit (freshwater) | 2 | Hornsea Mere (freshwater) |
| 3 | Tankerton Slopes and Swalecliffe (coastal/estuarine) | 3 | Flamborough Head & Bempton Cliffs (coastal/estuarine) |
| 4 | Thanet Coast (coastal/estuarine) | 4 | Isles of Scilly (coastal/estuarine) |
| 5 | Grimsthorpe (lowland dry sites) | 5 | Rutland Water (freshwater) |
| 6 | Dew's Ponds (freshwater) | 6 | Abberton Reservoir |
| 7 | Rochdale Canal (freshwater) | 7 | Marazion Marsh (lowland wet sites) |
| 8 | Cumbrian Marsh Fritillary Site (lowland wet sites) | 8 | Falmouth Bay to St Austell Bay pSPA (coastal/estuarine) |

| | | | |
|---|---|---|---|
| 9 | Clints Quarry (freshwater) | 9 | Thanet Coast and Sandwich Bay (coastal / estuarine) |
| 10 | Tregonning Hill (Lowland dry sites) | 10 | Chew Valley Lake (freshwater) |

### b) Ecosystem ranks

The three most fragmented sites in each habitat category are presented in Table 4. The full rankings for each habitat category, including scores for fragmentation and the other vulnerability metrics are available in Annex 4.

**Table 4 Three most fragmented Natura 2000 sites in each broad ecosystem category**

| | | | |
|---|---|---|---|
| | **Coastal / Estuarine SACs** | | **Coastal / Estuarine SPAs** |
| 1 | Tankerton Slopes and Swalecliffe | 1 | Northumbria Coast |
| 2 | Thanet Coast | 2 | Flamborough Head & Bempton Cliffs SPA |
| 3 | Isles of Scilly Complex | 3 | Isles of Scilly |
| | **Freshwater SACs** | | **Freshwater SPAs** |
| 1 | Ensor's Pool | 1 | Hornsea Mere |
| 2 | Crookhill Brick Pit | 2 | Rutland Water |
| 3 | Dew's Ponds | 3 | Abberton Reservoir |
| | **Lowland wet SACs** | | **Lowland wet SPAs** |
| 1 | Cumbrian Marsh Fritillary Site | 1 | Marazion Marsh |
| 2 | Newham Fen | 2 | Lower Derwent Valley |
| 3 | Baston Fen | 3 | Broadland |
| | **Lowland dry SACs** | | **Lowland dry SPAs** |
| 1 | Grimsthorpe | 1 | Sandlings |
| 2 | Tregonning Hill | 2 | Breckland |
| 3 | Paston Great Barn | 3 | Dorset Heathlands |
| | **Upland SACs** | | **Upland SPAs** |
| 1 | North Pennine Dales Meadows | 1 | Bowland Fells |
| 2 | Lake District High Fells | 2 | Peak District Moors (South Pennine Moors Phase 1) |
| 3 | Ingleborough Complex | 3 | South Pennine Moors Phase 2 |
| | **Forest SACs** | | **Forest SPAs** |
| 1 | West Dorset Alder Woods | | None |
| 2 | Great Yews | | |
| 3 | Rook Clift | | |

## 4.5 Fragmentation between Natura 2000 sites

Habitat fragmentation between Natura 2000 sites is a concern particularly for smaller sites potentially subject to significant edge effects, or sites designated for mobile interest features which contribute to a wider metapopulation (see discussion in section 2.1). It is important to consider the wider landscape context in order to make sense of the effects of habitat fragmentation on Natura 2000 sites.

The habitat fragmentation metric within the NBCCVA can be used to review how fragmented habitats are between Natura 2000 sites. The habitat fragmentation metric consists of: a sub-metric which measures the distribution of individual habitats, where larger aggregations of habitat are considered to be more resilient; and a second sub-metric which measures the distribution of semi-natural land cover types as a proxy for the 'permeability' of the land cover surrounding priority habitats. A national scale map of the habitat fragmentation metric with Natura 2000 site boundaries superimposed is provided in Annex 4. Maps of local areas are available from Natural England.

It is recommended that this data should be used as an interim measure, until more detailed analysis using the NBCCVA tool and other available data of the areas between Natura 2000 sites can be performed. This further analysis listed as a priority action in Table 5. Potential options for this analysis include: NBCCVA analysis of appropriate buffer zones around Natura 2000 sites and use of connectivity indicators (eg Watts and Handley, 2010) or other assessments of how structurally and functionally isolated or connected Natura 2000 sites are.

In addition to the basic habitat fragmentation metric, other products using different interpretations of the NBCCVA data are available for use by Natural England staff or are currently in development. For example analyses which help identify appropriate habitat creation and restoration areas for specific priority habitats were produced for the database supporting the Countryside Stewardship scheme. These data are available to use in assessments of terrestrial sites, and provide further information on habitat creation delivery, once a review of the fragmentation metric has given the broader picture. It is hoped that these will be made available for use by partner organisations in the future.

Other information and tools can also be used to evaluate habitat fragmentation in the wider landscape, including locally developed maps of habitat creation / restoration opportunities and the analytical tools described in section 3.2.

## 4.6 Model limitations and critical appraisal of results

Limitations of the NBCCVA approach have already been briefly mentioned and are discussed in more detail here. Additionally, this section discusses the critical appraisal that must be undertaken of all model results before they can be used with confidence to inform priorities and plans to improve habitat connectivity.

### Model limitations

#### a) Use of priority habitats

The approach assesses the fragmentation of 'priority habitats', which are those identified as being the most threatened and requiring conservation action under the UK Biodiversity Action Plan (UK BAP) (UK Steering Group, 1994) and section 41 of the Natural Environment and Rural Communities Act 2006. The Natural England priority habitat inventory data used in this assessment was created at a 200m grid scale nationally and analysis of the fragmentation of priority habitats has been carried out for the 200m grid squares that fall within IPENS sites. As outlined earlier, priority habitat data is considered to be a suitable proxy to assess Natura 2000 sites in the absence of Natura 2000 specific data, however, the limitations of this approach must be recognised.

Natura 2000 interest features are based on a different classification, as presented in annexes to the Habitats Directive 1994 and Birds Directive 1979. Many Natura 2000 interest features are either species, habitats not covered by UK BAP priority habitats, or are specific components of priority habitats. It is therefore difficult to cross reference the two classifications so the NBCCVA data can only go some way towards identifying the fragmentation of Natura 2000 sites and their features. Whilst priority habitats are represented throughout the Natura 2000 network, this makes it difficult, at a national scale, to assess fragmentation for individual designated features of specific sites such as species, however, the fragmentation scores from the NBCCVA are useful in identifying which sites need to be considered more carefully, thereby helping to set priorities for action in relation to potential habitat creation and restoration to increase connectivity.

Another issue with the reliance of the approach on priority habitats is that it only covers terrestrial and coastal habitats. All Natura 2000 sites with only marine (including coastal sub-tidal habitats such as reef) interest features have necessarily been omitted from the assessment. A further step to be investigated is the potential use of the NBCCVA tool to assess marine habitat fragmentation. The NBCCVA tool provides a flexible framework into which a range of available data is used to represent habitat types and a range of metrics assessed. Discussions about whether the tool can provide anything useful for a marine habitat assessment will be required.

### b) All sites are treated equally

The approach used treats all sites equally as it is unable to take into account any characteristics or issues specific to a site or its interest feature that may make a site more or less sensitive to fragmentation. For example, it is not possible for the model to distinguish between sites for which isolation is a problem and those where it is a necessity for the protection of special features. Neither can it judge whether a large isolated site would be more at risk than a well-connected small site. This means that there is a risk of divergence between model output and reality in some circumstances, for example, a site which appears to be fragmented when in fact it has quite a good mosaic of different natural land cover. In this example, however, the consideration of land cover permeability in the model means that in practice, where there is a high coverage of semi-natural habitat, it is likely to lead to a good score for the site, so mosaics are likely to appear as relatively un-fragmented. It is also important to note that although a number of island and pond sites appear high in the within-site fragmentation rankings, the model methodology means that this is not simply a result of them being intrinsically isolated sites. The wider results can be used to assess the habitat fragmentation within and surrounding the site, but the ranking is very largely based on the habitat fragmentation within each site. It nevertheless remains important that any such potential risks are carefully identified and evaluated using site specific data.

The NBCCVA output helps to give an overarching picture of the fragmentation of priority habitats within Natura 2000 sites and across a wider landscape setting. It is essential that how this relates to site features is interpreted at the site level. The results help to draw attention to areas of fragmentation and then the local critical appraisal process described below will help to determine how this affects site habitats and features and identify more specific actions. This local assessment will inform future fragmentation assessments of sites based on a wider understanding across all features of the site.

## Critical appraisal of the modelled fragmentation data

The habitat fragmentation data from the NBCCVA is a useful tool to guide consideration of fragmentation issues for Natura 2000 and other designated sites at the local level. However, as with all spatial analysis approaches there are uncertainties in the results as described above. It is essential that before using the results, the detailed fragmentation scores and rankings assigned to each site should be critically appraised and ground-truthed against what is known about particular sites at a local level to gain a good understanding of why the assessment has resulted in a particular outcome. Detailed issues and questions that should be considered by the critical appraisal include:

1. The position of the site in the fragmentation ranking of all sites. Consider the predominant ecosystem class assigned to the site and whether that influences position in the ranking.

2. Consider ranking positions within ecosystem categories in the context of the fragmentation ranking of all sites. A site may appear high in the ranking for a given ecosystem category, but relatively low in the all site ranking.

3. Does site specific information tally with the habitat fragmentation scores and ecosystem rankings? Do they accurately reflect what is known about the site?

4. Consider if a site has small patches of habitats that provide a specific benefit as they are, or a matrix of habitats that is not well reflected in the model data.

5. If the site does consist of small fragments of habitat that are beneficial for the notified features of the site, or the ranked position does not reflect the connectivity issues on site, consider whether reducing fragmentation, more general provision of green infrastructure or an approach to increase the size of the site or the permeability of surrounding sites might be most appropriate.

6. Consider whether the approach taken to designation, eg designating a series of habitat fragments that remained within a farmed landscape for their population of a particular species or for declining habitats, may have had an impact on the ranking of sites, ie if what remained of a population or habitat in an area was designated but this remains isolated from other similar sites, the site will be ranked as highly fragmented. Such sites may still need expanding or the landscape surrounding the site may need enhancing. The approach takes some of this in to account through the assessment of surrounding land cover types. Consider which approach best suits the site based on its wider position in the landscape.

7. Consider whether particular designated species or components of the habitat(s) are more vulnerable than the ranking suggests. For example is there a species that is a feature of the site that has specific dispersal requirements not reflected by these data. If so, further assessments of connectivity could be carried out to give more detailed information.

8. For the features of interest, what are the top priority areas, and do these coincide with the model results? If not, is there an obvious reason why? Refer to other sources of information where appropriate, eg the recent Natural England and Environment Agency priority river and lake habitat dataset (Mainstone and others, 2014; Hall and others, 2014).

9. Although attempts have been made to remove sites from the assessment that are only notified for marine habitat features (such as reefs and submerged features), sites with predominantly marine features which also contain some coastal or terrestrial priority habitats may still be included within the ranking. As part of a local assessment please discount these data if they do not reflect the issues for the site.

As a result of the critical appraisal, the position of a site within the fragmentation ranking may be confirmed, or where necessary revised to more accurately reflect the evidence available.

## Using the ranking to prioritise action

Having undertaken a critical appraisal of the model results and confirmed an acceptable ranking order for the sites of interest, the sites may be divided into high and lower priority classes to allow the identification of priority sites where specific action needs to be targeted first. Higher rankings indicate those where action may need to be prioritised in terms of scale and urgency. The use of priority classes will be of less relevance for local projects involving only one or two Natura 2000 sites, where the average habitat fragmentation score itself will indicate which site should be targeted first. For local project which include a few Natura 2000 sites, a simple approach to dividing the sites is suggested, assigning the top third of sites as high priority and the remaining two thirds as lower priority. This will be done locally by site managers / responsible officers but may in future feed into future priority ranking exercises.

### a) High priority sites

Sites in the high priority group are likely to require the most action and more urgently relative to other sites. For these sites connectivity plans should be developed and implemented first, using the framework outlined later in this section and in Annex 5.

### b) Lower priority sites

Sites in the lower priority groups are still likely to have a degree of habitat fragmentation that could be problematic. The detail of what action is required should be explored after work on high priority sites, as time and resources allow. The prioritisation of sites presented here should not prevent the exploitation of any opportunities that present themselves for improving connectivity.

Until such point as connectivity plans are made for lower priority sites, the following actions may be considered:

1. Identify what action is already being delivered, both on the site and in the surrounding area. Look for local projects which address specific issues of fragmentation and their impact so far on landscape scale

conservation. Information recorded on the Biodiversity Action Recording System, BARS, will be helpful (URL: http://ukbars.defra.gov.uk/).

2. Using the habitat creation and restoration NBCCVA data created for the Countryside Stewardship Scheme, identify whether the site is in a target area, and flag the site for future action, taking any opportunities that occur.
3. Take any opportunities that arise to improve the resilience of the site by increasing its size and connectivity with other nearby habitats to make the surrounding land more permeable to species movement.
4. Consider whether isolation of some sites / patches might be beneficial, for example for protection from invasive non-native species in the local area (see Annex 5, part 5). Weigh this against the wider objective of improving degraded habitats and landscapes.

Continue to apply best practice management consistent with European conservation objectives for the designated species and habitat interest features to achieve and maintain favourable condition and ensure the habitats on site are capable of supporting the largest possible populations.

### Case study – Applying the assessment method to Thorne Moor and Hatfield Moor SAC / SPA

Thorne and Hatfield Moors are remnants of the once-extensive bog and fen peatlands within the Humberhead Levels and together are the largest area of extant lowland raised bog peat in England, with a total Natura 2000 area of over 3000ha. They are designated as SACs for H7120 Degraded raised bogs still capable of natural regeneration and as a SPA for breeding nightjar *Caprimulgus europaeus*. This case study focuses on the SAC designation, to illustrate how the recommended national prioritisation process can operate at the site level.

**1. Within-site NBCCVA**

Model output (Figure 11) indicates that Thorne and Hatfield Moors are not highly vulnerable to within-site fragmentation, being in the bottom 10% of the fragmentation ranking (ranked 239 and 242 respectively). They are, however, relatively vulnerable to climate change (ranked 68 and 11 out of 242 sites respectively) for other reasons. Examination of the three other individual metrics contributing to the average overall vulnerability to climate change score suggests that the relatively high sensitivity of the priority habitats present on site (scores of 2.9 and 2.8 out of 3), coupled with the low degree of topographic variety (scoring 2.7 out of 3) are the main influences on the overall climate change vulnerability score in this location.

**2. Between-site assessment**

Examination of the national fragmentation scores map for the Thorne and Hatfield Moors area (Figure 12) reveals a paucity of priority habitats (areas coloured grey have no records of priority habitat) in the surrounding landscape. The few priority habitats that are present are mostly either moderately or highly fragmented (red and dark orange colours).

A significant patch of priority habitat does exist to the west of Thorne Moors, on the opposite bank of the River Don. Priority habitat data (available for Natural England staff via the Webmap system) suggests that this is mainly floodplain grazing marsh. Smaller patches of floodplain grazing marsh and woodland are present to the south of Hatfield Moors and between the two SACs. Figure 13 shows the presence of lowland fen, heath and raised bog in the area.

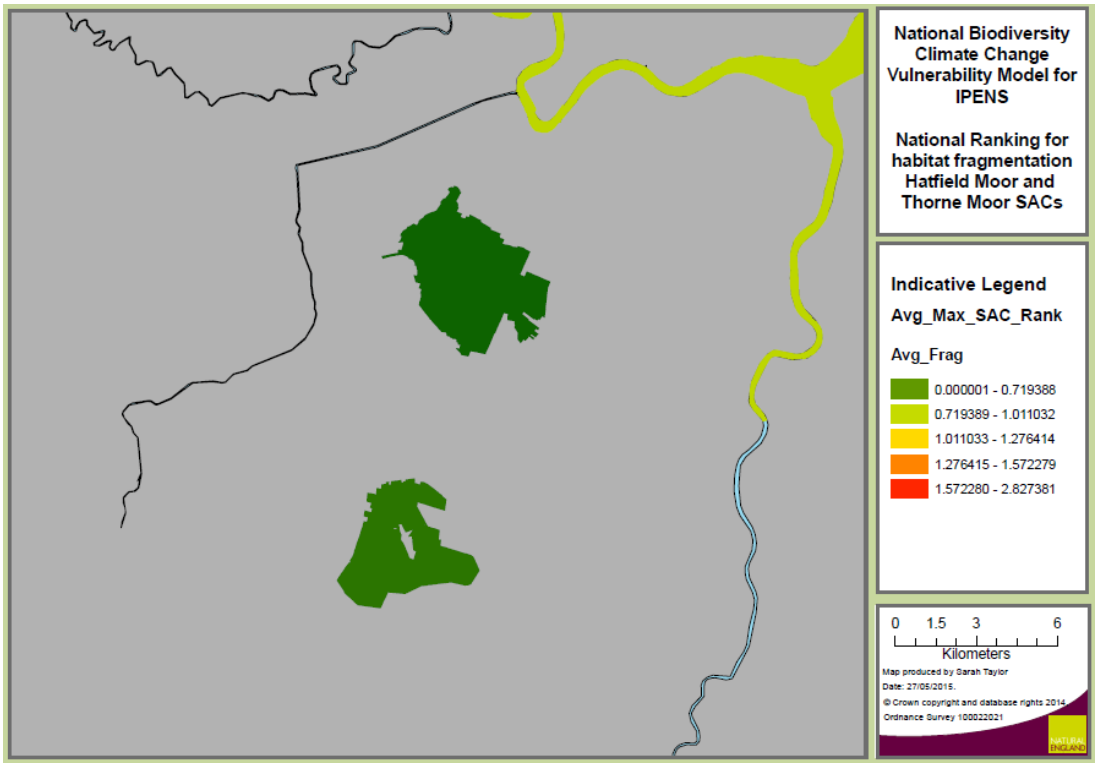



**Figure 11. Ranked habitat fragmentation scores for Thorne and Hatfield Moors SACs.** The indicative legend shows that sites that are green in colour have a lower within site average fragmentation score (sites coloured red have a higher than average fragmentation score). This shows that Thorne and Hatfield Moor SACs are in the less fragmented ranked sites.

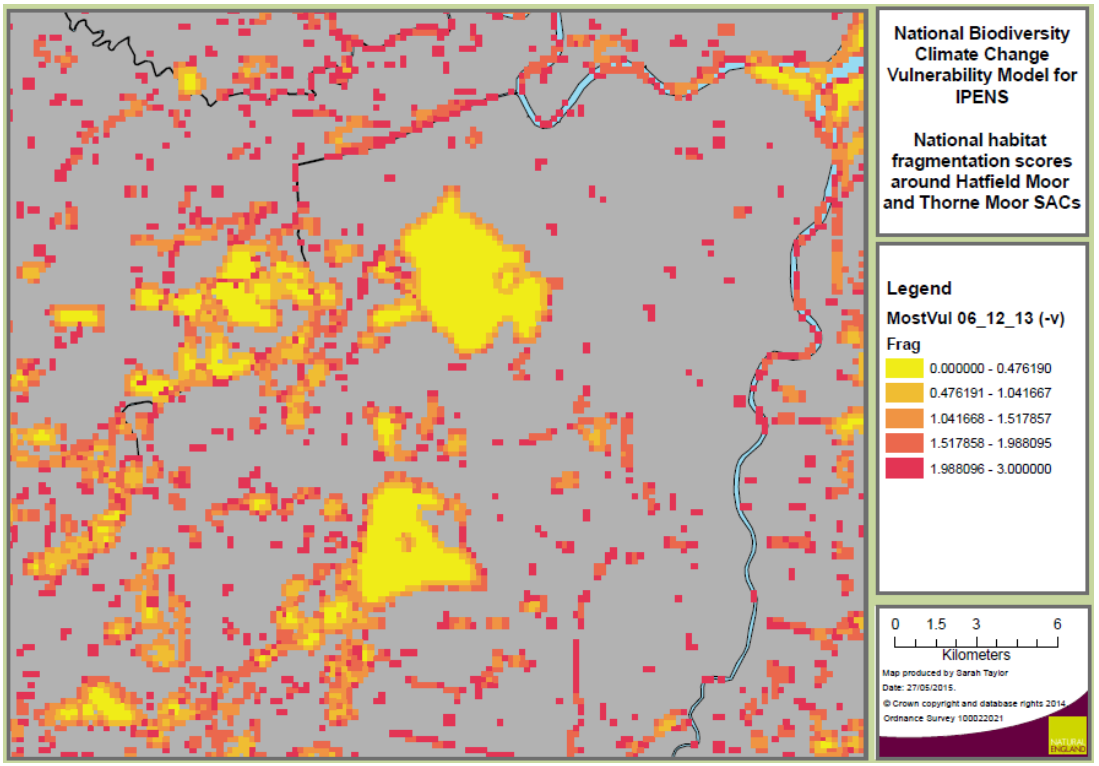



**Figure 12. Results of the Habitat Fragmentation metric for an area around Thorne and Hatfield Moors SACs.** The range of colours represents the range of fragmentation of habitats, showing the results for the most vulnerable habitat overall in each cell, with red indicating more fragmented and yellow less fragmented. This illustrates the structural nature of the assessment used in this metric and broadly shows that more semi-natural habitat in consecutive cells leads to less fragmented habitats. For example the larger contiguous areas of priority habitat in the SACs are highlighted as being of low fragmentation. This metric can help to identify areas that may benefit

from greater concentration on reducing habitat fragmentation. The GIS data can be interrogated to give greater detail on the habitats in the squares and the scores they receive.

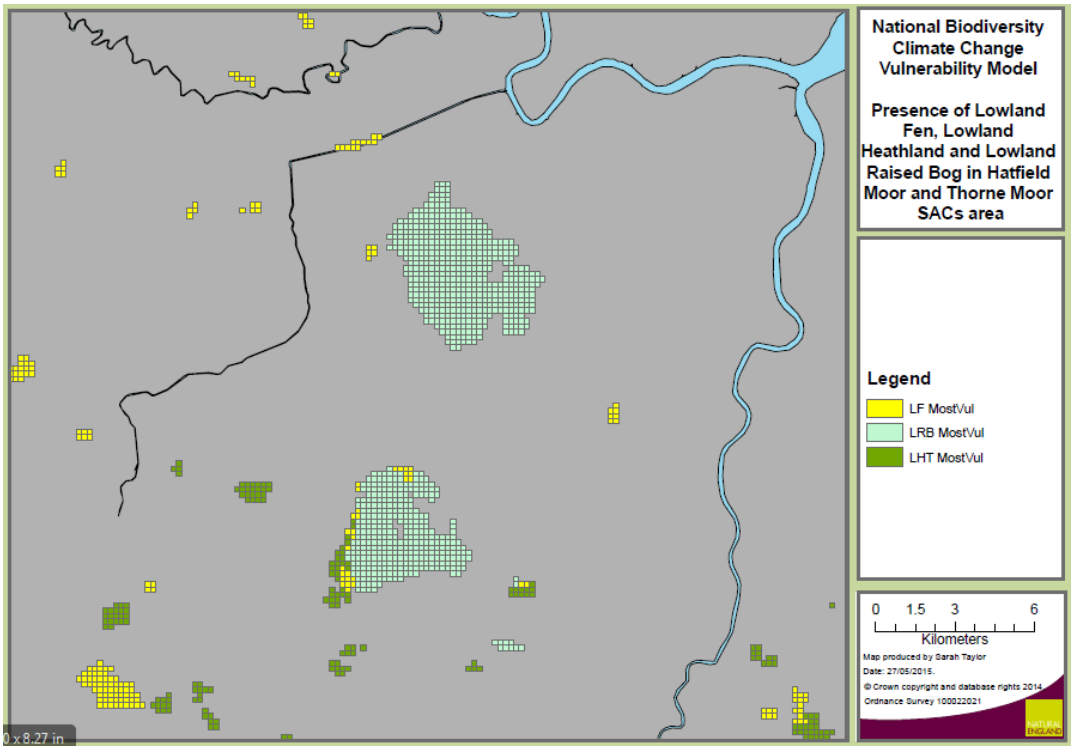



**Figure 13. Presence of lowland fen (yellow), lowland raised bog (light green) and lowland heathland (dark green) in the Thorne and Hatfield area.**

### 3. Critical appraisal

Factors relevant to the critical appraisal include:

- The large size of the site is likely to have been a significant influence on the low level of fragmentation within the site, combined with management generally being conducive to achieving favourable condition in the long term. Sites at the top of the fragmentation score rankings tend to be very small.
- The contrast between a low within-site fragmentation ranking and a relatively fragmented surrounding landscape (Figure 14) concurs with local information. The SAC sits within an area of intensively farmed, highly productive agricultural land, with little priority habitat.
- The approach to site designation (eg whether areas which are hydrologically important to the site remain outside of the site boundary) is not likely to have had a significant influence on the position in the fragmentation rankings, due to the large size of these sites. However, it will influence management as land within a buffer area around the raised mire will need to be appropriately managed in order to gain sufficient control of the hydrological regime within the site.

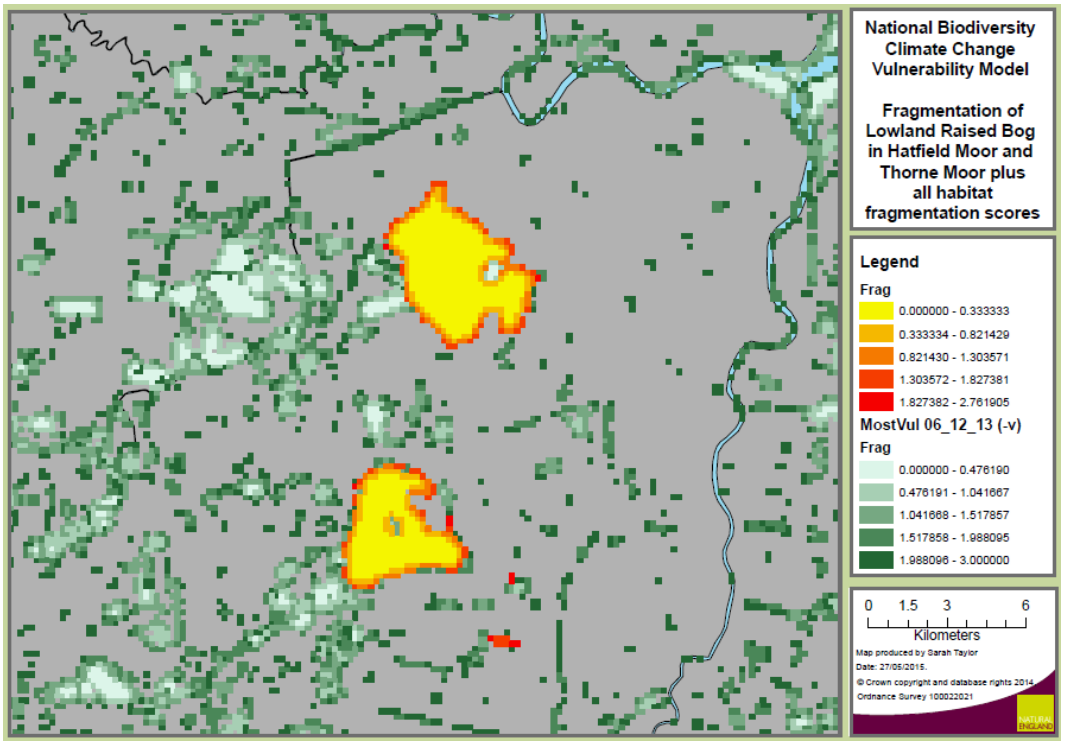



**Figure 14. Results of the Habitat Fragmentation metric for lowland raised bog at Thorne and Hatfield Moors SACs.** The range of colours represents the range of fragmentation of habitats, with red indicating more fragmented and yellow less fragmented. The wider habitat fragmentation scores for all habitats in the area (as illustrated in figure 12) are shown on this map in shades of green (dark green being more fragmented and light green being less so), in order to highlight the differences in fragmentation scores across habitats. It also highlights the availability of habitat specific fragmentation data.

**4. Conclusion**

The isolation of Thorne and Hatfield Moors within their wider landscape indicates that despite their low vulnerability to within-site fragmentation, action to improve connectivity with other habitats in the surrounding area should be a high priority. Further information on how relevant species may move between sites or where there are opportunities to functionally or structurally connect habitats in the area would enhance the initial information provided by the fragmentation data.

This conclusion accords well with what is happening on the ground. Management of the Natura 2000 sites is focussed on restoration of the degraded raised mire and maintenance of the habitat mosaic used by nightjar. The sites sit within the Humberhead Levels Nature Improvement Area and also within the Humberhead Levels Partnership Area, which aim to create lowland raised peat habitats and achieve sustainable water management. These are already benefitting the Natura 2000 sites through improvements to habitat connectivity.

## 4.7 A framework for developing site based connectivity plans

*Note that this section should be read in conjunction with Annex 5.*

Following the critical appraisal of the model output, local or site based implementation plans to 'defragment' habitats for the benefit of Natura 2000 interest features can be prepared. This will require the consideration of a range of environmental and social factors before the practical details of habitat restoration or creation are addressed.

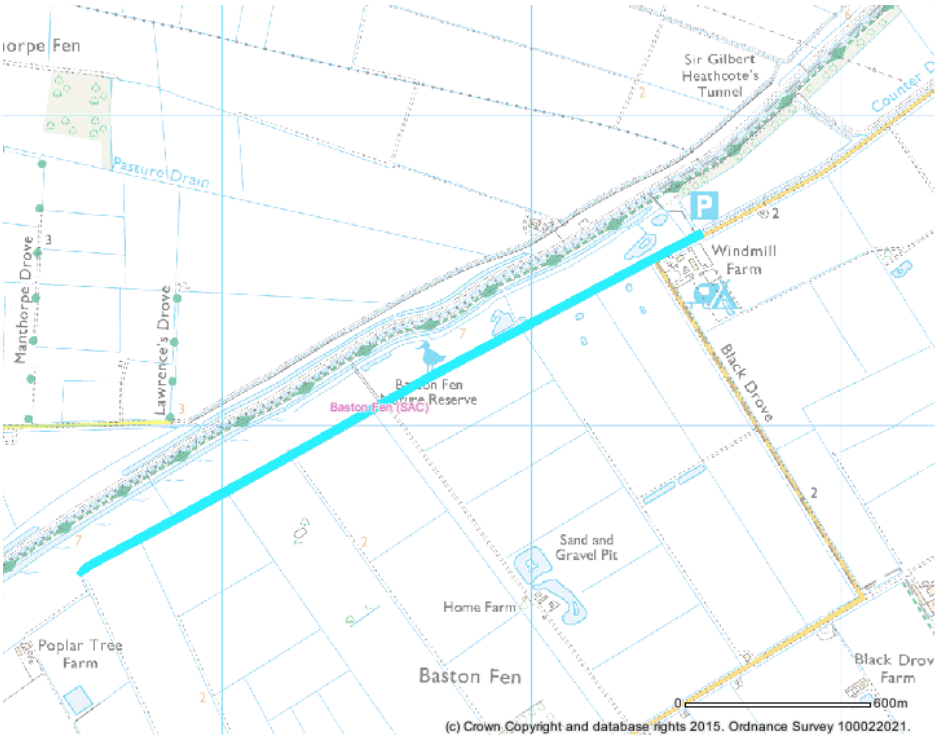
A detailed framework to guide thinking about increasing connectivity for Natura 2000 sites is presented in Annex 5; this should be read in conjunction with the framework for assessing connectivity and climate change adaptation needs, presented in EC guidance on the implementation of Article 3 of the Birds Directive and Article 10 of the Habitats Directive (Kettunen, 2007). It is suggested that the framework should be followed as the first step in the development of implementation plans. This theme plan does not provide details of practical habitat restoration and creation methods themselves. The framework recommends consideration of:

1. which Natura 2000 features to target;
2. any Natura 2000 specific issues within the wider area;
3. the type of action needed;
4. availability of spatial data for the area;
5. the potential effects of increased connectivity;
6. opportunities and priorities for funding;
7. Countryside Stewardship targeting data (eg the NBCCVA derived habitat creation data mentioned above);
8. the social context of the site or area;
9. working with partners to influence action in the wider environment; and
10. other useful information.

Following the proposed framework will help to avoid some of the potential problems that may arise when planning improvements to habitat connectivity. A case study from Baston Fen SAC (overleaf), illustrates the problems that may be encountered if certain elements of the framework are not sufficiently well examined.

**Case Study from Baston Fen (SAC) UK0030085**

**Baston Fen Nature Reserve:** This 35 ha reserve is the largest remaining area of wet fenland in Lincolnshire. Owned and managed by the Lincolnshire Wildlife Trust (LWT), this wetland reserve is the last stronghold for many endangered fenland plants, birds, molluscs & invertebrates. In winter large numbers of wildfowl are attracted to the flooded washlands, including wigeon & teal, while in summer dragonflies hawk over black peaty pools which hold rare aquatic plants such as frogbit, fen pondweed and greater water-parsnip.




**Map showing location of Baston Fen SAC**

- There are multiple landholdings around Baston Fen which include large and small landowners. The relationships between land owners form an important 'social context' to habitat restoration.
- The arable land extending to the north east of Baston Fen provided an ideal opportunity for expanding the habitat of this lowland wet SAC. From 1992 to 1995 the LWT worked with the Countryside Commission and Farming and Wildlife Advisory Group to persuade most adjacent landowners to apply for Countryside Stewardship funding to restore wet grassland over approximately 260 acres.
- Nearly ninety percent of land was available for restoration but a single farmer owning 12 acres of land blocked the entire scheme by refusing to consider re-wetting of his land. Because the area is a single hydrological unit, re-wetting could not proceed without support from all the farmers involved.
- Earlier recognition of the pivotal role of one farmer might have resulted in a better outcome.

# 5. Implementation and priority actions

## 5.1 Implementing the framework approach

Evidence presented in this theme plan, together with output from the NBCCVA, clearly shows that habitat fragmentation poses a significant threat to Natura 2000 sites in England and should therefore be considered a high priority for action, even though direct information on the extent of effects is hard to glean from site-based recording systems. To ensure the long term resilience of the English Natura 2000 sites to the effects of habitat fragmentation and secure good conservation status as required by the Habitats Directive, it will be necessary to assess and identify the vulnerability of the entire network and where necessary implement appropriate actions to reduce the risk.

In order to assess vulnerability, identify appropriate actions and implement them across the entire English Natura 2000 network, it is recommended that the national prioritisation and site based assessment approaches described in section 4 are implemented as soon as possible, so that they inform the development of plans for improving biodiversity post 2020. Other tools that are available (section 3.2) should be considered together with the approach recommended here, to produce outputs that will complement each other and potentially provide a more complete picture. In parallel to this, other work will be needed to identify success goals for habitat connectivity improvements, so that actions on the ground can be clearly measured against the requirements of the Habitats Directive (Table 5).

Implementation would ideally proceed as indicated in steps 1-4 below, with the proposed timescales (2016-2020) being subject to organisational agreement and availability of staff time and / or funding. It would be beneficial to progress a small number of sites (2-3) through the full process early in this timetable as pilot sites. The learning from these first sites should be reviewed to inform implementation of the approach to all high priority sites in the first instance, followed by lower priority sites. Sites listed in Tables 3 and 4 should be used as the initial short-list of candidate sites for consideration as pilot sites.

As implementation will require local site knowledge, it will primarily be a task led by Natural England staff, working with partner organisations. The approach could also be adopted by partner organisations independently, particularly if NBCCVA output is made more easily available to a wider audience in the future (see priority actions in section 5.2). It may also be possible to develop a project to coordinate or implement certain elements of the approach, with the possibility of attracting external funding.

The four implementation steps are:

### 1. Awareness raising

During 2015/2016, as part of the work which will be undertaken to implement the findings of the IPENS project, this theme plan should be disseminated to Natural England site responsible officers and managers and staff in partner organisations with responsibility for site management of Natura 2000 sites. Staff should be made aware of the proposed methodology in preparation for implementation and approval sought from management for the resources required to apply the assessment.

### 2. Critical appraisal

In 2016 / 2017 undertake a critical appraisal of the NBCCVA results (Sections 4.4 – 4.6 and Annex 4) for all Natura 2000 sites, to confirm the priority of each Natura 2000 site for developing plans to improve connectivity.

### 3. Update Site Improvement Plans

The Site Improvement Plans (SIPs) produced by the IPENS project for each Natura 2000 site are live documents and where necessary will be updated annually to reflect new understanding about issues affecting the sites. It is

recommended that Natural England staff should ensure that actions to implement the local connectivity planning process (high priority sites) or interim best practice actions (lower priority sites) described in section 4.6 are included in SIPs once priorities have been confirmed, and ideally in the 2017 revision to SIPs. This will ensure that climate change is included in SIPs in a consistent manner.

#### 4. Phased implementation of site based assessment

The site based assessment described in section 3.2 and Annex 5 should be initially applied to high priority sites and then rolled out to lower priority sites in phases in later phases. Ideally, site based assessment would be implemented on all high priority sites by 2020.

## 5.2 Priority actions

If obligations under the Habitats Directive to protect Natura 2000 sites are to be fully met, the strategic approach outlined in this plan needs to be complemented by a range of other actions to improve areas such as datasets and tools, funding, and reporting.

Table 5 identifies and summarises priority actions for further work which are discussed in earlier sections and suggests timescales by which they should be undertaken. Incorporation of these actions into Natural England corporate planning, both nationally and for Area teams, will be a task undertaken from summer 2015 onwards, as part of IPENS implementation work following closure of the IPENS project itself (see the IPENS AfterLIFE Implementation Plan which will be available via the IPENS website, URL: https://www.gov.uk/government/publications/improvement-programme-for-englands-natura-2000-sites-ipens).

**Table 5 – Priority actions**

| Action no. | Action description | Lead and partner bodies | Timescales |
|---|---|---|---|
| DEVELOPING THE STRATEGIC APPROACH, DATASETS AND TOOLS | | | |
| 1 | Apply the recommended prioritisation and planning approach to 2 – 3 pilot sites by the end of financial year 2016/17. Undertake critical appraisal of model results and update Site Improvement Plans for all sites by 2017. Develop connectivity plans for high priority sites by 2020 and for lower priority sites thereafter. | Natural England | 2015-2020 |
| 2 | Develop a vulnerability dataset for the NBCCVA model specific to Natura 2000 habitats and species. | Natural England | 2015 - 2017 |
| 3 | Undertake further NBCCVA modelling to specifically examine and quantify the degree of fragmentation in the wider landscape between Natura 2000 sites and other protected sites. | Natural England | 2015 - 2016 |
| 4 | Consider how to make NBCCVA output more widely available, initially within Natural England via Webmap, then publicly via MAGIC. | Natural England | Ongoing |

| | | | |
|---|---|---|---|
| 5 | Continue to investigate how new and developing habitat fragmentation and climate change based datasets can be best used to inform actions for Natura 2000 sites in the future eg NBCCVA, Lawton based outputs, restoring degraded habitats (Biodiversity 2020 outcome 1d) and refugia data. | Natural England | By 2017 |
| 6 | Investigate with Natural England marine team the creation of a methodology to assess the fragmentation of marine sites, for example, using the NBCCVA tool. | Natural England | 2015-16 |
| 7 | Plan for data updates and changes to ensure that the best, newest and most appropriate available datasets are used in future fragmentation assessments. In particular evaluate how existing data could be developed to better represent Natura 2000 interest features. | All appropriate partners | Ongoing |
| 8 | Investigate how different fragmentation and connectivity assessment tools can be used individually and in combination to provide the most appropriate information and evidence to support action on increasing fragmentation. | Natural England with partners (a new knowledge exchange project at Liverpool University may address this action) | 2016 (Natural England investigative project). Work done by partners might have different timescales. |
| 9 | Investigate the use of the Species Threats and Opportunities data could be used to inform fragmentation analysis and action. | Natural England | 2015 - 2018 |
| FUNDING | | | |
| 10 | Explore the potential for developing an externally funded project to implement the strategic approach outlined in this plan across the English Natura 2000 network. | Natural England | 2015 - 2016 |
| 11 | Develop a funding strategy with partner organisations to influence funding bodies and increase the amount of external funding allocated to connectivity projects. | Natural England, partner organisations | Ongoing |
| 12 | Continue to work with partner organisations to secure funding to develop and implement connectivity projects which benefit Natura 2000 sites. | Natural England, partner organisations | Ongoing |
| SITE DESIGNATION | | | |
| 13 | Investigate means of protecting land with no special interest for the purpose of habitat creation or connectivity, including buffer areas. | Natural England | Ongoing |
| PARTNERSHIP WORKING | | | |

| | | | |
|---|---|---|---|
| 14 | Engage with partner organisations with landscape scale conservation initiatives to explore how they may be better targeted to benefit Natura 2000 sites. | Natural England working with RSPB, Wildlife Trusts and NIAs | Ongoing |
| COMMUNICATION AND REPORTING | | | |
| 15 | Investigate ways to communicate the risk to Natura 2000 sites of habitat fragmentation compared to that from other pressures. | Natural England | Ongoing |
| 16 | Identify 'success goals' for work to improve habitat connectivity on Natura 2000 sites, so that actions can be measured against 'favourable conservation status' and the requirements of the Habitats Directive. | Natural England | Ongoing |

# Annex 1. IPENS theme plans

The table below provides hyperlinks to the suite of IPENS theme plans, which are available on the Natural England publication catalogue.

| Theme plan | Hyperlink |
|---|---|
| Atmospheric nitrogen deposition | http://publications.naturalengland.org.uk/publication/6140185886588928?category=5605910663659520 |
| Climate change | http://publications.naturalengland.org.uk/publication/4954594591375360?category=5605910663659520 |
| Diffuse water pollution | http://publications.naturalengland.org.uk/publication/5848526737113088?category=5605910663659520 |
| Grazing | http://publications.naturalengland.org.uk/publication/4839898496368640?category=5605910663659520 |
| Habitat Fragmentation | http://publications.naturalengland.org.uk/publication/5004101806981120?category=5605910663659520 |
| Hydrological functioning | http://publications.naturalengland.org.uk/publication/6400975361277952?category=5605910663659520 |
| Inappropriate coastal management | http://publications.naturalengland.org.uk/publication/6371629661683712?category=5605910663659520 |
| Invasive species | http://publications.naturalengland.org.uk/publication/6130001713823744?category=5605910663659520 |
| Lake restoration | http://publications.naturalengland.org.uk/publication/5583022327857152?category=5605910663659520 |
| Public access and disturbance | http://publications.naturalengland.org.uk/publication/6621454219083776?category=5605910663659520 |
| River Restoration | http://publications.naturalengland.org.uk/publication/5478339747774464?category=5605910663659520 |

# Annex 2. Site improvement plan data

The table below lists those site improvement plans which report habitat fragmentation or habitat connectivity issues. As responsible officers for the sites did not have a consistent approach to follow while compiling this list, it is likely that it does not represent a comprehensive coverage of issues on Natura 2000 sites. The strategic approach outlined in this plan aims to address this issue.

| Site improvement plan | Pressure or threat |
|---|---|
| Aston Rowant | Pressure |
| Beer Quarry & Caves | Threat |
| Breckland | Threat |
| Breney Common and Goss & Tregoss Moors | Pressure |
| Burnham Beeches | Pressure |
| Cerne & Sydling Downs | Pressure |
| Cumbrian Marsh Fritillary Site | Pressure |
| Denby Grange Colliery Ponds | Threat |
| Dorset Heaths | Pressure/Threat |
| Downton Gorge | Threat |
| Ebernoe Common | Threat |
| Fens Pools | Threat |
| Isles of Scilly Complex | Pressure/Threat |
| Kirk Deighton | Pressure |
| North Meadow & Clattinger Farm | Pressure/Threat |
| Parkgate Down | Threat |
| Pewsey Downs | Pressure/Threat |
| Queendown Warren | Threat |
| Rex Graham Reserve | Threat |
| Thames Basin | Pressure |
| The Lizard | Pressure/Threat |

| | |
|---|---|
| The Mens | Threat |
| The Stiperstones and The Hollies | Threat |
| West Dorset Alder Woods | Pressure/Threat |
| West Midlands Mosses | Threat |
| Wimbledon Common | Threat |
| Wye Valley and Forest of Dean Bat Sites /<br>Safleoedd Ystlumod Dyffryn Gwy A Fforest Y Dena | Threat |
| Wye Valley Woodlands /<br>Coetiroedd Dyffryn Gwy | Pressure/Threat |

# Annex 3. Natural Environment White Paper commitments

The Natural Environment White Paper (Defra, 2011a) makes a range of commitments which relate directly to large-scale conservation and ecological networks. The detail of these is listed below.

| Commitment no. | Detail |
|---|---|
| **A vision for nature** | |
| 3 | Our 2020 mission is to halt overall biodiversity loss, support healthy well-functioning ecosystems and establish coherent ecological networks, with more and better places for nature for the |
| **Local nature partnerships** | |
| 4 | We will encourage and support Local Nature Partnerships where local areas wish to establish them. These partnerships will work at a strategic scale to improve the range of benefits and services we get from a healthy natural environment. They will aim to improve the multiple benefits we receive from good management of the land. |
| 5 | Partnerships which fulfil the broad vision set out in this White Paper will be recognised by Government and its environmental bodies. We will host an annual Ministerial event at which partnerships can come together to share best practice, discuss implementation issues and celebrate success. We will maintain a partnership database on the internet. |
| 6 | The Government wants to provide support to both new and existing partnerships wishing to adopt an integrated, landscape scale approach. We will provide a one-off fund in 2011/12 worth £1 million, to develop Local Nature Partnerships. |
| **Nature Improvement Areas** | |
| 8 | We will enable partnerships of local authorities, local communities and landowners, the private sector and conservation organisations to establish new Nature Improvement Areas (NIAs), based on a local assessment of opportunities for restoring and connecting nature on a significant scale. |
| 9 | To provide inspiration and illustrate what works the Government will support the creation of Nature Improvement Areas. Natural England will set up a competition to identify 12 initial areas. We will provide £7.5 million over the current Spending Review period. |
| 10 | Working within the framework of the National Policy Statements and the Government's planning reforms (see below), local authorities will be able to use local planning to support Nature Improvement Areas, including identifying them in their local plans where they choose, while not deterring sustainable development. |
| 11 | We will capture the learning from Nature Improvement Areas, and review whether further action is needed in planning policy, regulation or capacity building, to support their development. |
| 13 | We will maximise the contribution which Environmental Stewardship and the Woodland Grant Scheme make towards our over-arching objective to promote multiple benefits from ecological restoration at a landscape scale, including through Nature Improvement Areas. |

| | |
|---|---|
| **Protecting and improving our woodland and forests** | |
| 21 | The Government welcomes the case the “Read Report” sets out and has asked the Independent Panel on Forestry to provide advice on an appropriate level of ambition for woodland creation and more active management, the mechanisms and market conditions needed and options for ensuring everyone has the opportunity to experience and enjoy our woodland resource. |
| **Restoring nature in our rivers and waterbodies** | |
| 28 | We are establishing ten catchment-level partnerships to develop and implement plans for creating and maintaining healthy water bodies. We will also support additional groups who wish to take a lead in trialling a catchment approach. |
| **Restoring nature in our towns, cities and villages** | |
| 32 | The Government will work with its transport agencies and key delivery partners to contribute to the creation of coherent and resilient ecological networks, supported, where appropriate, by organisation-specific Biodiversity Action Plans. We will host a forum with environmental stakeholders to inform future priorities for the enhancement of these green corridors. |
| **Connecting through better neighbourhood access to nature** | |
| 67 | The Government will establish a Green Infrastructure Partnership to support the development of green infrastructure in England. This will consider how green infrastructure can be enhanced to strengthen ecological networks and improve communities’ health, quality of life and resilience to climate change. |

# Annex 4. Spatial prioritisation data and results

Results from the NBCCVA are available in spreadsheet and map format on the Natural England publication catalogue page for the Habitat Fragmentation Theme Plan:

http://publications.naturalengland.org.uk/publication/5004101806981120?category=5605910663659520

The following are available:

**Spreadsheets:**

1. NBCCVA results spreadsheet for SACs.

2. NBCCVA results spreadsheet for SPAs.

Both spreadsheets include overall climate change vulnerability scores, ranked overall vulnerability scores, ranked fragmentation scores and scores for each of the four contributing metrics to the overall vulnerability scores (fragmentation, sensitivity, topographic variety and management and condition). Please refer to the 'READ ME' tab on each spreadsheet for an explanation of the content.

**Maps:**

1. National overall climate change vulnerability scores with SACs boundaries overlain.

2. National overall climate change vulnerability scores with SPA boundaries overlain.

3. Overall climate change vulnerability analysis for SACs.

4. Overall climate change vulnerability analysis for SPAs.

5. National fragmentation scores with SAC boundaries overlain.

6. National fragmentation scores with SPA boundaries overlain.

7. Fragmentation scores for priority habitat on SACs.

8. Fragmentation scores for priority habitats on SPAs.

9. SACs ranked by average fragmentation scores.

10. SPAs ranked by average fragmentation scores.

Maps and spreadsheets should be used in conjunction with this theme plan and detailed information about the NBCCVA model (Taylor and others, 2014).

# Annex 5. Developing connectivity plans – detailed advice

## A framework for developing site based connectivity plans

*This annex provides supporting detail for section 4.7.*

The framework below intends to guide thinking for increasing connectivity to benefit Natura 2000 sites. The starting point for use of this framework is any site or group of sites which have been identified by the spatial prioritisation and critical appraisal process described in sections 4.2 to 4.6 as a high priority for action to improve connectivity. The framework builds on this starting point by prompting areas for consideration and further analysis in order to develop site based connectivity plans which benefit Natura 2000 sites. It moves from consideration of the detailed requirements of each site, to data and identification of where habitat improvements can be made, and finally social, funding and partnership working issues.

### 1. Identify which Natura 2000 features to target

Use the SAC and SPA site accounts on the UK Protected Sites pages of the Joint Nature Conservation Committee (JNCC) (URL: http://jncc.defra.gov.uk/page-4) to confirm the habitat and species interest features for which the site is designated. Conservation objectives for European Sites and supporting information can be found via the Natural England publication catalogue: http://publications.naturalengland.org.uk/category/6490068894089216.
Once the interest features have been identified, three things should be considered:

**a) What factors are of ecological importance for the Natura 2000 features?**

Identify what factors are of importance (ecological requirements) for the designated features (habitats and species). Many will have very specific requirements, which should help to determine what management action is needed to reduce fragmentation. The following links will provide a useful starting point:

- SPA species accounts (Stroud and others, 2001)
- SAC Annex I habitat accounts (JNCC)
- SAC Annex II species accounts (JNCC)

**b) Which Natura 2000 sites or features are most at risk?**

The Natura 2000 species or habitats for which a site is designated will vary in the degree to which they are affected by habitat fragmentation. Whilst the prioritisation methodology outlined in section 4 gives an overview of how fragmented each Natura 2000 site is, this does not indicate which features are most at risk in ecological terms. Once the ecological requirements of the Natura 2000 features have been identified, this information should be used to determine which features are most at risk, given current levels of fragmentation and potential greater fragmentation in the future, for example, fragmentation of the supporting habitat for relatively sedentary species may pose a higher risk than for species which are more mobile and better able to move between sites.

**c) Which Natura 2000 sites or features are most suitable for improvement?**

For ecological, practical or economic reasons, some interest features may be more suitable for improvement by increasing landscape connectivity than others. It is important to gather this type of information to assess the feasibility of improvement plans or to inform decisions about the level of funding needed before practical work can start.

Prioritising the needs of potentially conflicting networks for different overlapping habitats is likely to need wider agreement than situations where interest features have more complementary requirements. For example, the requirements of certain orchid species will be similar to that of the grassland habitat in which they occur. In

contrast, where both woodland and grassland habitats are priorities for management, their requirements are likely to conflict. One way of doing this may be to consider priorities at different spatial scales (national, regional, local), with the greatest weight assigned to national priorities.

### 2. Identify any Natura 2000 specific issues

In many locations, improvements to habitat connectivity are likely to be planned for areas where Natura 2000 sites are a relatively small component of the landscape, although this is not always the case. The purpose and objectives of Natura 2000, and the configuration of protected sites in the landscape may present specific issues which need to be addressed, particularly if such sites form a large component of a proposal. EC guidance in Kettunen and others (2007) is clear that measures should be taken by Member States when they deem improved connectivity to be necessary for the maintenance or restoration of a Natura 2000 species or habitat at favourable conservation status (FCS). Any information that is available to help determine what FCS looks like for a particular feature (for example Conservation Objectives for European sites and Supplementary Advice, available via the gov.uk website), may also help to determine whether improved connectivity is necessary.

There are examples of landscapes which are relatively rich in Natura 2000 sites, such as the borders of Hampshire/Dorset and Wiltshire which are characterised by the near contiguous Natura 2000 sites of the Dorset Heaths, Avon River and Valley, the New Forest and the Solent Coast. Such landscapes are probably less fragmented than most, and so the emphasis for further work may need to be protection of the existing network. In other situations where only remnants of formerly widespread habitats remain, Natura 2000 sites may be scattered widely, for example the Norfolk Valley Fens SAC, which is a typical 'archipelago' site. Here, the focus may need to be more on creating habitat to restore connectivity.

### 3. Spatial data

Other data that is useful in the assessment and design of ecological networks should be gathered, for example maps of existing protected areas, land cover, species ranges and priority areas. These data can be used to identify specific aspects of the site that might make it more vulnerable to compounding issues. Partners should work closely with Natural England to explore opportunities (see Table 5 for data product publication aims).

There will also be a wide range of data from other conservation organisations or partnerships that will be useful in identifying actions, including maps showing areas where there may be opportunities for habitat creation or restoration (habitat opportunity mapping), for example the maps produced by the Wetland Vision partnership project, and local ecological network assessment and design that should be identified and used to inform site based plans (see examples in section 3.2).

As habitat fragmentation contributes to the climate change vulnerability of a site, it is important to integrate actions to reduce fragmentation with other actions to build climate change resilience. Other NBCCVA metrics can be used to identify broad adaptation actions which should also be a priority for implementation on site (see the Climate Change Theme Plan for more information).

For the future, it is important to record improvements such as habitat creation and restoration on the site or in the surrounding areas using systems such as BARS, to enable updates on the condition of fragmented habitats in the vicinity, and potentially move sites out of the high priority category.

### 4. Identify the type of action needed

Once the interest features requiring increased connectivity have been identified, the ecological aspirations for the site and features need to be carefully considered, in light of the recommendations made in 'Making Space for Nature' (Lawton, 2010). Depending on the species or habitats involved, the most appropriate and effective means may (in no particular order) be to:

- Create more sites

- Enlarge existing sites
- Improve the condition of sites, or
- Create 'stepping stone' habitats or linear features in the wider environment.

Action may be required within a Natura 2000 sites or in the area surrounding it.

The spatial configuration and size of the Natura 2000 sites in an area may be informative for planning purposes. For example, 'archipelago' sites with many spatially scattered components may be more suitable for action in the environment between them ('joining'), to better connect each part of the site. Alternatively, very large sites may require action to defragment component habitats within the site ('bigger', 'better'), rather than action in the surrounding area. Other sites may require buffering by habitat creation around their boundary.

A number of detailed analytical tools, such as Condatis and BEETLE, are being developed to help identify priorities for management to enhance ecological networks (see section 3.2). Natural England is also developing tools to assist with this eg using data from the NBCCVA approach to reflect where the Lawton priorities could be achieved. Partner organisations should liaise closely with Natural England if such data is required as it is not currently available in a published format.

## 5. Consider the effects of increased connectivity

Improvements to habitat connectivity should help with the resilience of landscapes to climate change and other environmental impacts, and will open up pathways for the movement of species between sites. Research has shown that connectivity may also lead to an increased risk of spread of invasive species, but the increased habitat resilience resulting from improved connectivity has been suggested as a means of reducing the spread of invasive species. In general, the benefits of increased connectivity will probably outweigh the risk of invasive species for Natura 2000 sites, but there may be certain circumstances where steps need to be taken to protect particularly vulnerable Natura 2000 interest features. This may be particularly true where populations of an invasive species are known to exist close to a vulnerable site. Examples (from Knight and others, 2014) include Asian longhorn beetle, *Anoplophora glabripennis,* which if it became established in the UK would benefit from larger patch areas and a greater number of patches of broadleaved woodland and could lead to devastating effects on various native tree species. Further information can be found in Knight and others 2014.

## 6. Consider the social context

Having critically appraised the modelled fragmentation data, the social context of the land surrounding the highest priority sites should be examined, particularly where the ambition is to increase the size of the site or influence the management of adjacent land. Positive trusting relationships amongst local landowners and between landowners and local people will: (i) reduce farmers' perceptions of risk associated with land use change and (ii) increase farmers' desire to provide public benefits from their privately-owned land. Steps for considering the social context can follow the pattern below:

1. Using a map which extends beyond the immediate site, list the names and identify the landholdings of adjacent landowners. Indicate their interest in (or dislike of) habitat management, noting any prior engagement with any agri-environment scheme.

2. Work with colleagues in partner organisations and Natural England to:

    a. prioritise landowners or other land managers who might be interested to support the goals of habitat reconnection;
    b. Identify the correct social mechanisms (eg appealing to senses of 'duty' and social status – or using financial incentives) to prompt behaviour change in key individuals.

3. Identify landowners who might resist habitat improvement, especially where collaborative approaches are essential (eg raising water levels in hydrologically-connected land parcels). If not identified at the outset and engaged with the habitat restoration proposals, these individuals may discover their power to block changes to land management after many years of work, thereby rendering the whole project impossible (see Baston Fen SAC case study in section 4).

## 7. Opportunities and priorities for funding

While developing plans for an ideal ecological network, enough flexibility should be incorporated to ensure it is possible to react to opportunities that arise. The following questions may help to prompt thinking:

a) Which sites / features are most suitable for improvement ie which should be a priority for funding and are there any quick wins?
b) Are there any local projects that plan to address specific issues of fragmentation and what is their impact so far on landscape scale conservation in the area?
c) What are other partners doing?
d) Are there any existing partnerships that are better placed to deliver aspects of this network?
e) What plans do national bodies have? For example, the Environment Agency capital schemes, Water Companies, National Trust.
f) What are the priorities for funding partners and can the proposal be aligned with these priorities in order to maximise the chance of securing funds? Potential funders include Heritage Lottery Fund, EU LIFE, as well as smaller organisations that provide grants.
g) Are there any existing projects which can be enhanced or expanded to include delivery of the proposed network?
h) Who are the main landowners and can they be invited to join a partnership working group or provide funding?
i) Who are the 'winners' from the scheme? Who are the 'losers' who might wish to stop the scheme? What approaches should be used to engage both groups with the Vision for the scheme?

## 8. Countryside Stewardship targeting

The ministerial priority for Countryside Stewardship (CS) is to secure improvements to biodiversity. The scheme will also make an important contribution to meeting water quality commitments under the Water Framework Directive and to realising opportunities to deliver biodiversity, water quality and flooding benefits together (synergies). To do this effectively, a national targeting framework has been developed, which articulates the ministerial priorities for implementation on the ground. This framework utilises a data matrix of around 400 datasets, including data on habitat creation and restoration opportunities from the NBCCVA, which are related to the Rural Land Register at a parcel level. This helps to identify land where the application of CS options would be particularly effective in meeting the priorities described above.

The targeting framework has been used to develop local targeting statements at the National Character Area (NCA) scale. These statements are to help potential CS applicants understand how best to choose and target options to maximise their chance of a successful application. The statements are due for publication early in 2015.

CS targeting and local targeting statements are focussed on achieving Biodiversity 2020 targets (Defra, 2011b) so refer to Biodiversity Action Plan (BAP) 'Priority' habitats and species rather than Natura 2000 sites or interest features (although where the two are coincident, Natura 2000 features are covered). Importantly, Biodiversity 2020 outcome 1b aims to achieve 'more, bigger and less fragmented areas for wildlife' so CS targeting is a vital means of improving connectivity in the most effective locations, both within Natura 2000 sites and the wider environment. CS restoration options can be used flexibly to link and join up Natura 2000 sites.

The approach recommended in this plan for addressing habitat fragmentation is complementary to that set out in CS local targeting statements, so the two can be used together to inform action at the site level, and determine

whether CS may be a potential delivery mechanism. Applications for all CS options relating to priority habitats and species will be within the higher tier of CS, so applicants will get one-to-one advice from Natural England advisers, who will be able to negotiate the best options for more complex management requirements, including habitat creation and restoration. Wider countryside benefits relevant to increasing connectivity and reducing fragmentation at a larger landscape scale may be accrued through the mid-tier scheme that encourages groupings of farmers to work together, facilitated by an independent advisor. Such advisors could be key contacts for enhancing the development of a local ecological network.

## 9. Working with partners to influence action in the wider environment

The creation of a resilient ecological network that reduces habitat fragmentation and provides greater long term security for species will take time, and the coordination of action across the landscape will be essential. This has evolved a more holistic approach through the expansion of projects such as Living Landscapes and inclusion of a wide range of partners. Many organisations have either a statutory duty of care through the Countryside and Rights of Way Act 2000 or have organisational objectives which mean they are best suited to work in partnership. Ecological connectivity lends itself to delivery through partnerships which are built over a number of years on trust, communication and mutual understanding of priorities, with a collective drive to enhance the environment. Local Nature Partnerships / Biodiversity Partnerships have a fundamental role in facilitating the development of robust, supported partnerships to achieve ecological networks across their area, although funding can be a constraint to their success.

## 10. Other useful information

Habitat fragmentation contributes to the climate change vulnerability of sites, so other assessment metrics from the NBCCVA model can be used to target where adaptation actions should be a priority for implementation. Further information can be found in the climate change theme plan (see Annex 1).

Related to this, Natural England has published a Climate Change Adaptation Manual, which will also be useful as a source of background information and recommendations for improving the resilience of specific habitat types.

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# Annex 7. Authors and contributors

**Authors:**

David Appleton

Ian Crosher

Simon Duffield

Julie Erian

Jilly Hall

Nicholas Macgregor

Naomi Oakley

Sarah Taylor

**Contributors:**

Stella Baylis, Natural England

Pete Brotherton, Natural England

Clive Chatters, Hampshire & Isle of Wight Wildlife Trust

Dominic Coath, Environment Agency

Brendan Costelloe, Royal Society for the Protection of Birds

Humphrey Crick, Natural England

Christopher Hancock, Somerset Wildlife Trust

Eleanor Higginson, Somerset Wildlife Trust

John Hiskett, Norfolk Wildlife Trust

Jenny Hodgson, Liverpool University

Alison Jukes, Natural England

John Kilner, Defra

Stuart Masheder, Natural England

Ben McCarthy, Plantlife / Natural England

Kate Morris, Natural England

Andy Neale, Natural England

Tom Oliver, CEH

Stephen Peters, Environment Agency

Chris Pirie, Natural England

Ann Skinner, Environment Agency

Ian Taylor, Natural England

Tim Thom, Yorkshire Wildlife Trust

Phil Tolerton, Natural England

Andy Tully, Defra

Kevin Watts, Forest Research

Richard Wright, Natural England

Michelle Young, Natural England

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