# Ecologically connected network think piece

## Creating a network of protected sites and areas that could be created and managed to protect a dynamic natural world with bio-geodynamism being accelerated by climate change

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# Foreword

Natural England's SSSI Future Reforms project commissioned several 'Think-Pieces' to inform discussion with stakeholders to develop a vision for what we want Sites of Special Scientific Interest (SSSI's) to deliver in future, and how we can best support the 25 Year Environment Plan to achieve 75% of protected sites in favourable condition by 2043, in the face of inevitable change to the natural world due to the Climate Crises. This report is one such think-piece providing a response to the question:

> We are interested in your thinking on how an 'Ecologically Connected' network (ECN) of protected sites / areas could work in England, based on the following draft vision:
>
> 'Creating a large and 'Ecologically Connected' Network of Protected Sites / Areas as a key component of 30 x 30 and the Nature Recovery Network, that is actively monitored and adaptively managed to ensure its effectiveness at conserving bio-geodiversity in the face of dynamic change'.

Natural England commission a range of reports from external contractors to provide evidence and advice to assist us in delivering our duties. The views in this report are those of the authors and do not necessarily represent those of Natural England.

# Executive summary

Ecologically Connected Networks are “areas of particular importance for biodiversity and ecosystem services and 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 landscape and seascape” (JNCC, 2019).

The aim of the study is to explore the merits and challenges of developing an ECN of protected sites and areas across England, which will anticipate and respond to changes within the natural system, specifically as these are accelerated by climate change.

Protected areas in England play a critical role in climate change adaptation. To ensure our natural environment is more resilient, protected areas need to be bigger, better managed and more connected, as a key recommendation of Sir John Lawton’s 2010 Making Space for Nature report (Lawton, et al., 2010). England’s current system is failing to deliver its objectives, with ongoing species declines and resulting loss in biodiversity, leading to increased occurrences of at least local extinction; both linked to evidence of a widespread and accelerating collapse in bio-abundance (State of Nature Partnership, 2019).

The formation of an effective ECN would be undertaken in several steps:

Identifying areas of importance for biodiversity and ecosystem services by reviewing the current information held on terrestrial, freshwater and marine habitats and species populations in a centralised location along with the ecosystem services these deliver and existing threats and opportunities. The information would then be used to develop a national model identifying the location of significant barriers to connecting protected areas. The ECN would therefore be formed of protected areas (core areas), connectivity corridors that identify opportunities for habitat restoration and creation (buffers), and stepping-stones; thus, delivering an ECN in line with the recommendations in Lawton’s report.

Where deficiencies in habitat representation are identified, the information can be used to review the adequacy of the protected sites (SSSI) system and equally, to prioritise the quantum and location of habitat restoration and creation.

Delivering good connectivity would be achieved by using the baseline information collected to identify habitats suitable for both generalist and specialist species and incorporate corridors that may theoretically support these into the ECN.

In recognition of ecological dynamism as reflected by habitat succession, species fluctuations and distribution, a more flexible protected site designation system is probably required, especially in view of the amplified scenario already in evidence as caused by climate change. A selection system based around exemplarity also becomes increasingly questionable under such circumstances.

Once established, the ECN would need to be managed adequately and appropriately, which would be achieved through:

- Sufficient funding for land management
- A robust planning, legal and enforcement system that is also sufficiently funded
- Collaboration across multiple stakeholders to encourage agreed consensus around priorities and higher standards for positive land management.

Funding models for land management need to be reviewed to ensure these are financially advantageous, and this could be achieved through setting land management objectives pending actual delivery of enhanced biodiversity and ecosystem services, rather than focussing these on the condition of (possibly out-of-date) specific notified features. Funding to maintain and protect habitats in good condition is also critical to incentivise and reward good management.

Appropriate funding also needs to be provided to the planning system and its enforcement to upskill existing teams and ensure they understand the priorities and objectives set for the ECN. Adequate legal enforcement of their statutory protection is also critical to achieving this purpose.

Delivering objectives for biodiversity and ecosystem services requires collaboration across multiple and varied stakeholders. Recommendations for how this could be achieved is explored in the report and can be summarised as:

- Encouraging land managers to commit to memoranda of understanding or equivalent governance agreements with regards to biodiversity and ecosystem services objectives and delivery within the ECN.
- Requiring landowners and land managers to undertake baseline assessments following DEFRA biodiversity net gain metric as part of funding applications.
- Provision of workshops for stakeholders on opportunities for biodiversity and delivery of ecosystem services within connected landscapes
- Development and provision of online tools to support land managers in the decision-making processes with regards to land management and activities.

The ECN should be assessed against biodiversity and ecosystem service objectives which better reflect changing baseline conditions, their causal threats and opportunities. Monitoring the ECN is critical to understand and measure the impact of land management activities aimed at recovering biodiversity and delivering ecosystem services; to provide accountability and transparency; and to track progress set at a local, regional, national and international level. Determining whether an ECN is delivering its objectives, the following would be required:

- Development and imposition of nationally standardised monitoring protocols that measure biodiversity and bio-abundance, and the delivery of ecosystem services.
- Ensuring budgets at a national, regional and local scale incorporate robust and cost-effective monitoring regimes with legally bound targets.
- Monitoring targets should be revised regularly, and their measurement should be based on the best science available; reflecting climate change mitigation and

related advances in technology (e.g., use of remote sensing, and metabarcoding of soil and pollen material).

The information collected can be used to monitor biodiversity, bio-abundance and also the relationship of both of these in terms of their net delivery of ecosystem services, both in aggregation and as ascribed to the particular habitats and species collectively responsible. Better coordination at a national level to make use of citizen science, existing national monitoring strategies, local biological record centres, and special interest species groups is also required to deliver monitoring effectively across England.

The UK has committed to a series of targets through its international obligations, including Target 11 of the Aichi agreements to create an ECN. As demonstrated, this is achievable, although the highest political will is required to robustly implement novel sustainable economic models and impose the necessary cross-sectoral collaboration with stakeholders; that will ensure biodiversity recovery and the unconstrained supply of renewable ecosystem services to firmly embed climate resilience and reliable adaptation for all.

# Contents

# 1 Introduction

Ecologically Connected Networks are “areas of particular importance for biodiversity and ecosystem services and are conserved through effectively and equitably managed, ecologically representative and well-connected systems of protected areas and other effective area-based conservation measures, [and *sic.*] integrated into the wider landscape and seascape” (JNCC, 2019).

Surrey Wildlife Trust (SWT) Ecology Services was commissioned on 10 January 2022 by Natural England to prepare a ‘Think Piece’ on an Ecologically Connected Networks (ECN). The aim of the study is to explore the merits and challenges of developing an ECN of protected sites and areas across England, which anticipates and can react to changes within the natural system, specifically as changes are being accelerated by climate change.

In August 2021 the Intergovernmental Panel on Climate Change (IPCC) confirmed that human influence has warmed the atmosphere, ocean and land, resulting in widespread and rapid changes across the globe (Inter-governmental Panel on Climate Change, 2021). In its sixth assessment report on impacts, adaptation and vulnerability, the key messages in the IPPC’s assessment are:

- Impacts of climate changes are being felt across the globe with increased heatwaves, droughts and floods already exceeding plants’ and animals’ tolerance thresholds, driving mass mortalities in certain species and ecosystems.
- **Ambitious, accelerated action** is required to adapt to climate change, whilst making rapid **deep cuts to greenhouse gas emissions**.
- The window of opportunity to effect change is closing and **adequate funding**, **technology transfer, political commitment** and **partnership lead** are required for more effective climate change adaptation and emissions reduction.
- Nature plays an important role to minimise climate risks and improve people’s lives. The key is to have **healthy ecosystems** (Inter-governmental Panel on Climate Change, 2022).

We therefore need to ensure that any future mechanism for biodiversity protection and ecosystem service delivery incorporates these recommendations to adapt to climate change.

Ecosystems and their biodiversity provide human society with essential ecosystem services: they sequester carbon, purify water, pollinate food, provide shelter, underpin well-being, reduce pollution etc. England’s ecosystems have evolved over billions of years, and since their emergence in the UK 50-90,000 years ago, humans have been manipulating the environment and its component ecosystems, leading to a dynamic landscape by universal anthropogenic influences, further evidenced in the Anthropocene age.

According to the Office of National Statistics, the most natural habitats in the UK are 'semi-natural', which account for 32% of the land area within the UK (Office of National Statistics, 2021; although the majority is in Scotland and Wales). Within England, a significant proportion of the semi-natural habitat is within protected areas.

The Convention of Biological Diversity (CBD) defines a protected area as:

> "a clearly defined geographical space, recognised, dedicated and managed, through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem services and cultural values" (CBD, 2008).

Protected areas are critical for site-based conservation, forming a key pillar of the CBD Strategic Plan for Biodiversity (2011-2020) (Starnes, et al., 2021).

In England, protected areas comprise:

- Statutory protected sites:
    - Special Areas of Protection (SPA)
    - Special Areas of Conservation (SAC)
    - Sites of Special Scientific Interest (SSSI)
    - National Nature Reserves (NNR)
    - Local Nature Reserves (LNR)
    - Marine Conservation Zones (MCZ)
- Non-statutory protection:
    - Local Wildlife Sites (LWS)
    - Local Geological Sites/Regionally Important Geological Sites (LGS/RIGS)
    - Conservation Road Verges
- Landscape Designations
    - National Parks
    - Areas of Outstanding Natural Beauty (AONB)

These protected areas play a critical role in climate change adaptation, however appropriate funding, objectives, monitoring and adaptation within these is required to deliver the required cut to greenhouse gases via the policy aspiration for "...ambitious, accelerated action required to adapt to climate change." Protected areas (specifically SSSIs) also present a fundamental role as Britain's biodiversity resource, and therefore underpin the UK's contribution to the Convention on Biological Diversity (including the 20 Aichi targets) (JNCC, 2019).

In Sir John Lawton's independent review of England's wildlife sites (i.e. protected areas) and the extent of their ecological inter-dependence, this report identified that this latter was singularly lacking, but was nevertheless essential to create a more resilient natural environment for the benefit of wildlife and people (Lawton, et al., 2010) to be achieved by:

- Improving the **quality** of the sites
- Increasing the **size** of the sites

- **Enhancing connections** between these through physical corridors or stepping-stones
- Identifying **new sites**
- Increasing habitat resilience by **improving the wider environment** and **incorporating buffers**

These are well-established principles within landscape ecology as they allow species to move freely across the landscape and provide them with the space to adapt to their environment, building resilience to accelerated changes brought by climate change (Smithers, Cowan, Harley, & Pontier, 2008).

Whilst these recommendations have informed policy over the last decade (HM Government, 2018), England is still experiencing losses in biodiversity and resilience, demonstrating that the current system is not delivering its objectives (State of Nature Partnership, 2019). Furthermore, the UK has only half of its biodiversity left, meaning it is the least diverse in the G7 countries and is within the bottom 10% of all countries globally (Davis, 2020). This is further supported in a recent review of SSSIs in England, which demonstrated an increase in areas of SSSI classed as unfavourable, with the long-term and short-term trend as declining between 2011 and 2019 (Office of National Statistics, 2021) (JNCC Resource Hub, 2020).

This Think Piece therefore focuses on how an ECN could be formed, managed, monitored and assessed, whilst delivering the Lawton Report's recommended "bigger, better and more connected" network of ecological corridors.

# 2 Forming an Ecologically Connected Network

The formation of an ECN would be undertaken in several steps:

- Identifying areas of importance for biodiversity and ecosystem services
- Reviewing ecological representation
- Delivering effective ecological connectivity

The sections below detail how this would be achieved.

## 2.1 Identifying areas of importance for biodiversity and ecosystem services

Ecosystems are dynamic and evolve with time and in response to environmental conditions. Traditionally, protected areas have been selected to represent specific features (e.g., qualifying interest features for SPAs and SACs; special interest features for SSSIs etc), and success is monitored against set anthropogenic criteria.

The Ratcliffe Criteria is a long established and widely accepted method for determining the nature conservation value of a site (Ratcliffe, 1977). Its principles have been used in the identification of protected areas at an international (Natura 2000 sites, SPAs and SACs), national (SSSIs) and local (LWS) scale (JNCC, 2019) (Gibbs, 2008). Although the weight of emphasis varies depends on the type of protected area, these are broadly:

- Typicalness with respect to the habitats represented
- Fragility and a habitat or species' ability to adapt to impacts to natural processes
- Size which can be a broad size description (e.g., the bigger the area, the more diverse the habitat) or species populations at a regional or national level
- Diversity of the habitat or species diversity, or diversity of the communities present
- Naturalness, including the capacity for a natural process to occur and continuity across the landscape
- Ecological coherence and its functional importance within a landscape. For SSSIs this specifically refers to forming a core area within a planned network
- Potential value with regards to how a species or habitat respond to good ecological management

A challenge with the current definitions is that many of these relate to specific features or species, rather than the broad assemblage that the protected areas support. Furthermore, monitoring to determine whether a protected area is performing its role, relates specifically to its selection features rather than how the protected area performs in the wider landscape. Therefore, where these features or species are adversely impacted by climate change and development pressures, or our understanding of the relationship between species and their habitats alter, the criteria could no longer apply. This then adversely impacts the ability for a local or national government to protect the area against impacts. For example, in reviewing planning applications, we regularly see consultant ecologists contest the status of Local Wildlife Sites on behalf of developers based simply on their selection criteria no longer being met and not on their role in landscape scale conservation strategy. This then increases the pressure on ecosystems at a landscape scale and gives developers and land managers the impression that maintaining a protected area is optional rather than critical to landscape resilience and climate change adaptability.

In identifying the location of an ECN across England and the role of protected areas within these the following information needs to be collected centrally to ensure decisions are made based on an accurate data set. This includes:

- Forming a single GIS layer that brings together all protected areas (both statutory and non-statutory designated sites), Habitats of Principal Importance and habitats that support Species of Principal Importance and other ecosystem service assets within England;
- Through both desk study and field work (especially where data are deficient), establishing baseline information within protected areas with regards to species diversity and abundance, delivery of ecosystem services and habitat condition;
- Identification of threats to biodiversity and ecosystem services;

- Identification of areas that are deficient in biodiversity and delivery of ecosystem services;
- Opportunities for biodiversity enhancements (including species diversity and species abundance) and delivery of ecosystem services to target specific climate change adaptations that are required based on current models;
- Location of barriers across the landscape that hinder ecological connectivity (at community, species and genetic levels).

The information above would be used to define the location of sites within the ECN by developing a landscape-scale model that identifies networks displaying the least strength in barriers (e.g., hard landscape features such as extensive buildings, infrastructure etc). The baseline information collected would be used to determine appropriate objectives within the ECN. Whilst protected areas are likely to represent the core of the ECN, additional important features may be identified through this process. The ECN would therefore be formed of protected areas (core areas), connectivity corridors that identify opportunities for habitat restoration and creation (buffers), and stepping-stones that would be formed of more isolated patches of habitat that delivers biodiversity and ecosystem service objectives; thus, delivering an ECN in line with the recommendations in Lawton's report.

## 2.2 Reviewing ecological representation

Ecological representation refers to a sample of the full variety of biodiversity to ensure the long-term persistence of all species and ecosystems within a protected areas network (Elliot, Gah, Hartley, & Vis, 2017).

Lawton's primary objective was to review the current system for conserving nature in England for its effectiveness against modern pressures. The report concluded that the protected site selection aspect of the system actually remained sound; that is to comprehensively represent national biodiversity by merit of exemplarity. The identification and selection methodology may indeed be sound, but Lawton is, arguably, inadequately critical of the ecological stasis implied by this system.

It is commonly accepted across the conservation sector that a significant proportion of the originally notified features of interest on SSSI are now lost, do not reflect better and more recent species status reviews, or worst, may have been based on inaccurate information to begin with. Habitat features may also have since changed such that it is wholly unrealistic to suggest they will ever support these lost species again. In consequence, re-establishing ecological representation within protected sites is long overdue to ensure continuity of representation for all the core habitats and species groups within England. The geo-diversity equivalent is where better exemplars of geological phenomena have been exposed or simply discovered, since the original selection of Geological Sites of Special Scientific Interest (GSSSI). If anything, and probably because the scale is more manageable, geological exemplarity has been kept more regularly updated by new notifications and denotifications.

This would be achieved by having a clear vision for fundamental review to adequately reflect a current representative sample of terrestrial, freshwater and marine habitats and species populations within the ECN. Where deficiencies in habitat representation are identified, the information can be used to review the adequacy of the protected sites (SSSI) system and equally, to prioritise the quantum and location of habitat restoration and creation (Gimona, Wright, Eastwood, Gallego, & Hester, 2020).

## 2.3 Delivering good connectivity

Connectivity can be defined as corridors that allow species and their genetic variation to migrate and disperse relatively unimpeded across the landscape, and ecological processes to function uncompromised (United Nations Environment Programne, 2019). This facilitates climate adaptation using an ecosystem approach. Generalist species adapt readily to their surroundings, whilst specialists require very specific habitat conditions to facilitate movement across the landscape. Therefore, delivering good connectivity requires an understanding of the habitats and species present in an ECN, the degree to which they can move across the landscape along with what measures are required to facilitate this movement. Connectivity therefore requires a mosaic of habitats that can be used by both generalist and specialist species, with wide-ranging comparative mobility, and use of a consistent approach to developing an ECN and connectivity corridors.

Whilst delivering good connectivity is important, improving the quality and quantity of protected areas, may be more important in delivering climate change resilience and adaptation.

Biodiversity Opportunity Areas (BOA) presents a method of identifying baseline connectivity across the range of biodiversity features within a landscape, for use in prioritising habitat restoration and habitat creation. Information on BOAs is provided further in this report. The identification of opportunities for repairing, enhancing and consolidating connectivity will also assist in prioritising the delivery of biodiversity net gain and offsite compensation, to ensure connectivity objectives are met, along with objectives for biodiversity and ecosystem services.

# 3 Managing an ecologically connected network: effective and equitable management

Land management is undertaken by a range of stakeholders, including governmental agencies (national and local level), private landowners and tenants. The effective management of an ECN requires:

- Appropriate funding for land management;
- A robust planning, legal and enforcement system that is appropriately funded;

- Collaboration across stakeholders to encourage positive land management.

These aspects are further explored below.

## 3.1 Funding for land management

Approximately 4,000 SSSIs exist in England, covering approximately 7% of England's land area (Natural England, 2008). Twenty percent of these are owned by public bodies (e.g., local authorities, statutory undertakers and public authorities), meaning the remaining 80% are in private ownership. Furthermore, some of the land is leased to long-term and short-term tenants which adds extra complexity when delivering conservation objectives in the current financial climate (Moody, 2022).

Currently, Natural England's aim is for all SSSIs to be in favourable condition and land managers are required to effectively and appropriately manage the land to conserve the special interest features of the sites.

Current cost of land management to deliver existing strategies, objectives and commitments is estimated to be £2.3 billion per year (RSPB, National Trust and Wildlife Trust, 2019). Whilst UK's current natural capital is valued at £1.2 trillion (Office of National Statistics, 2021) significant financial contributions are required to deliver these ecosystem services. Furthermore, consideration also needs to be made to consider the adverse impact climate change will have on the UK economy, which is currently estimated to be £20 million per year to the UK government by 2050 (Times, 2022).

The successful delivery of an ECN requires the delivery of land management to be financially sustainable in addition to the cost of assessing, monitoring and enforcement. Current economic and political drivers demonstrate that added financial strains can be experienced by all stakeholders, including local, regional and national government budgets, environmental management, assessment monitoring and enforcement are not prioritised in budgets.

In reviewing the cost of land management, RSPB, National Trust and Wildlife Trusts recommended:

- Better integration between environmental targets, and farming and land management policies and payments;
- Significant increase in available funding for environmental land management;
- Consideration of other costs when designing future farming and environmental policies.

In a review of the current Environmental Land Management scheme landowners were found to be reluctant to enter into such agreements due to tax implications and long-term financial burdens (Moody, 2022). Currently landowners can sell biodiversity credits to developers so they can meet their offsite compensation, with an estimated value of between £15,000 and £25,000 per unit. However, this would require landowners to set

their land aside to deliver specific biodiversity credits for a minimum of 30 years. Considering the current economic climate and food security landowners and tenants are not incentivised to manage their land for biodiversity and are not rewarded for maintaining habitats in good condition and are therefore finding alternative and more financially advantageous ways to manage their land. For the ECN to be successful, financial support needs to be designed to provide a sustainable model that is financially advantageous to land managers, so that they can maintain habitats in good condition and positively deliver measures to benefit biodiversity and ecosystem services.

Consideration could be made to reviewing the cost of land management against habitat types to determine whether adjustments can be made to land management objectives such that funds are redirected towards delivering other measures that benefit biodiversity and ecosystem services within an ECN. As an example, formally reviewing the relative percentage cover of later successional habitats within lowland heathland would decrease the land management costs and also sequester more carbon, whilst maintaining an ecologically functional habitat. Although this may adversely impact immediate existing condition targets, site/habitat expansion (via restoration from extensive non-native conifer plantations) could counter this, and the wider benefits to biodiversity and delivery of ecosystem services at a landscape scale would in the long-term outweigh the immediate impacts, without increasing the total financial burden.

## 3.2 Robust planning, legal and enforcement system

A robust planning, legal and enforcement system that is funded appropriately is required to ensure the delivery of an ECN. With the advent of the Environment Act (2021), a key concern at a local government level is having sufficient knowledge and funding to implement their obligations and ensure the appropriate enforcement can be implemented where required.

It is understood that funding will be provided to local government to upskill relevant teams to enable adequate regulation of biodiversity net gain assessments and their implementation, although the extent of available funding is not currently assured.

Whilst many protected areas receive statutory protection, many do not which makes it challenging to ensure biodiversity and ecosystem service objectives to be met. As such, it is advised that all the ECN receive a more secure form of statutory protection, and this is enforced at a national level to remove the burden on local government.

## 3.3 Collaboration

A key factor in delivering an ECN is collaboration across national agencies, local and county authorities, local groups and communities to ensure biodiversity and ecosystem services objectives are met (Maxwell, et al., 2020). To achieve this, collaboration with stakeholders at a local, regional, national and international level is essential and has been

demonstrated to be successful in the past (Olsson & Folke, 2001) and (Gimona, Wright, Eastwood, Gallego, & Hester, 2020).

The Department of Food, Environment and Rural Affairs (DEFRA) has published guidance on the code of guidance for encouraging positive partnerships (DEFRA, 2003). Current guidance identifies the need for constructive relationships to provide better protection to SSSIs and provide clarity to stakeholders with regards to activities that can cause harm, reflecting that damaging impacts to protected areas can often be caused by misinformation, lack of information and funding restrictions.

Guidance is currently available on the government's website with regards to the actions landowners need to take if their land is on a SSSI, and whether consent or assent is required (Natural England, 2020). The language used in the current guidance is informative, however does not include advice on how a landowner can meet a site's biodiversity and ecosystem services objectives, whilst engaging in a landowner's activity.

The following options could be considered to enhance collaboration at a local, regional, national and international scale:

- Encouraging land managers to sign a memorandum of understanding or agreement with regards to the activities on the land. These would be developed in partnership with Natural England and would offer a landowner the opportunity to discuss how their land could be managed for biodiversity and ecosystem services whilst considering a landowner's financial commitments. This would be reviewed regularly and would provide a landowner with the opportunity to discuss challenges they face with Natural England so that advice could be provided on collaborative delivery of a site's biodiversity and ecosystem services objectives in a financially sustainable way. Currently the focus is very much on SSSIs, however this should be broadened to all elements of an ECN (protected areas, buffer zones, and stepping-stones).
- Provision of workshops for stakeholders (landowners, tenants, local community groups etc) within an ECN with a particular emphasis on protected areas, connectivity corridors and stepping-stones, along with opportunity areas. These would allow landowners to understand how their activities can impact biodiversity and ecosystem services, and also provide an opportunity for them to engage with the local Natural England team. Local workshops would also provide guidance where opportunities for habitats and nature-based solutions should be focused and prioritised.
- Development and provision of online tools and factsheets to again reflect some of the challenges that stakeholders face and provide pragmatic solutions so that they focus on delivering these in the context of their activities within the ECN.
- Better coordination at a national level to make use of citizen science, existing national monitoring strategies, local biological record centres, and special interest species groups is also required to deliver monitoring effectively across England.

# 4 Assessing and monitoring an Ecologically Connected Network

## 4.1 Assessing an ECN

In 2021, Natural England developed Impact Risk Zones for SSSIs which allow Local Planning Authorities to assess planning applications for likely indirect impacts to SSSIs (Natural England, 2021). These are very useful as they allow stakeholders to make rapid assessments of the impact of development on SSSIs. However, the audience is focused on Local Planning Authorities, and requires users to have a good understanding of where to find suitable information in their decision-making process. Whilst some impacts to protected areas occur from development, impacts can also occur through other activities unrelated to the planning process (e.g. farming, permitted development, conservation activities), but which occur in the catchment and/or zone of influence.

Furthermore, the current impact risk zone focusses only on SSSIs and whether a proposal can adversely impact notified features, rather than potential impacts on general biodiversity or ecosystem services. The tool is therefore very restrictive, and its use would need to be broadened to allow users to understand which activities could impact the ECN. On this basis, the ECN should be assessed against biodiversity and ecosystem service objectives which reflect the baseline conditions, threats and opportunities.

Any tools developed to assist land managers in understanding whether their actions could adversely impact biodiversity and ecosystem services, should be designed in consultation with stakeholders to ensure this adequately reflects their needs and ensures use.

## 4.2 Monitoring an ECN

Monitoring is “the repeated observation of a particular set of circumstances from which an impression may be gained of changes over time from an established or notional baseline state” (Surrey Wildlife Trust, 2019). Monitoring an ECN is critical to understand and measure the impact of land management activities aimed at promoting biodiversity and delivering ecosystem services, to provide accountability and transparency and track progress set at a local, regional, national and international level (UN Environment Programme, 2021). Monitoring can demonstrate whether land management regimes have positive, neutral or negative outcomes. The information can then be used to determine whether funding of land management can be altered to deliver the desired outcome.

Within the UK, statutory protected sites are monitored with the Common Standards Monitoring Protocol setting out a six-year monitoring cycle. Non-statutory designated sites do not have formal monitoring protocols, and as it is the responsibility of the Local Authority to deliver monitoring regimes of these, they are often not undertaken due to funding challenges. In 2021 it was reported that 78% of SSSIs in England had not been

monitored in the last six years (Pow, 2021). No national figures exist for other statutory or non-statutory designated sites.

Monitoring can take many forms, including habitat or species distribution, habitat condition, or presence or absence of certain species.

The current monitoring methods (CSM) for SSSIs involves determining the state of the features at the time of recording (JNCC, 2019). CSM includes survey protocols for a range of broad habitat types as well as for species groups. SSSIs are then recorded as being in favourable or unfavourable condition, or destroyed, and whether these are recovering (moving towards the desired favourable state), declining (moving away from the desired state) or no change. Sites that are unfavourable: recovering can mean that the state of the feature is unsatisfactory, but because a management plan is in place, it is moving in the right direction. However, if the management actions proposed are not being undertaken, or are not appropriate for that feature, the site is still recorded as unfavourable recovering, which does not adequately reflect the stage of the feature accurately.

Currently variable data, targets and objectives are used, which makes it difficult to assess and report on progress, therefore having standard methods that can be delivered by all land managers and reported to Natural England by landowners will ensure consistent reporting.

Targets would require desirable habitat condition outcomes measuring biodiversity (including bio-abundance) and delivery of ecosystem services rather than focussing on specific features. Collecting this type of information would allow for an assessment of the ecological functionality of habitats within the ECN to be made, and land management measures to be adjusted to address any deficiencies.

On this basis, monitoring could be achieved by:

- Habitat condition assessments in line with the DEFRA biodiversity net gain metric (Natural England, 2021) (Panks, et al., Biodiversity Metric 3.0: Auditing and Accounting for Biodiversity: Technical Suplement , 2021b) (Panks, et al., Biodiversity Metric 3.0: Auditing and Accounting for Biodiversity - User Guide, 2021). The biodiversity net gain metric uses habitats as a proxy to biodiversity (Baker, Hoskin, & Butterworth, 2016) which is particularly useful where data on species occurrence and distribution is deficient. Habitat condition assessments have been developed for each main type of habitat, irrespective of their location in the country. Features assessed are specific to the habitat type, but include elements such as sward height and structure, characteristics, cover of bare ground and variety of age classes in addition to proportion of invasive non-native species. The latter may need to be revised based on the changing climate and scientific advances with regards to what is considered invasive and non-native. Training would need to be provided to ensure all stakeholders could undertake the monitoring consistently and this could be supported by third parties. Developing an appropriate Key Performance Indicators (KPIs) for the ECN would depend on the current baseline condition and should include a percentage of habitats in good and

very good condition over a given period, reflective of what could be achieved in each habitat type.

- Monitoring the delivery of ecosystem services within the ECN would be undertaken by inputting the information collected during habitat condition monitoring into an EcoMetric. Additional information that would be added to the metric, includes results of statutory monitoring such as the water quality monitoring on water quality and levels on river catchments undertaken by Environment Agency and water utilities. The use of an EcoMetric is more technical and as such this would most likely have to be undertaken by Natural England or a specific consultant with the appropriate expertise. KPI would include improvements on ecosystem services delivery.
- Develop a habitat connectivity model that establishes a baseline, and from which progress in repairing fragmentation across the landscape through habitat management, restoration and re-creation interventions can be monitored. Surrey Wildlife Trust has developed such a model using Circuitscape® to identify Urban Biodiversity Opportunity Areas in Surrey (see below) and has also applied this model to prioritise green and blue infrastructure corridors within Hastings. The model calculates an index of landscape “resistance” to species’ movement to act as a proxy for habitat fragmentation. Once developed, the model would be run in line with the monitoring cycle and an analysis of habitat fragmentation across the landscape would need to be undertaken. This work would be undertaken by Natural England, or a specialised consultant that has a good understanding of landscape ecology.
- Species monitoring can either be done by undertaking a complete census of a population, which would be challenging to achieve at the ECN level due to resource constraints and data variability; or landscape-scale monitoring. Species monitoring is important to maintain knowledge how species and habitats respond to climate change. Cost-effective monitoring could include:
    - Comparing clusters of monitored populations for their demographic synchronicity across the landscape supporting a meta-population of indicator species (Oliver, Powney, Baguette, & Sctickzelle, 2017). Further research would be required to determine which species could be used as an indicator species.
    - Grid mapping monitoring can also be used to provide objective and comparable measures of the condition and distribution of individual species and species assemblages at a site (Callahan, 2013). This would complement the habitat monitoring discussed above. Grid mapping would involve carefully choosing attributes to monitor management outcomes, through a deliberately simplified auditing and evaluation protocol, such that those with limited identification skills can be trained to participate. GIS tools would be used to divide the ECN into a grid system and randomly select sampling points. Attribute of species should be relatively recognisable and could also include “flagship” species but must be indicators of improving conditions in terms of enhanced diversity as a response to management (Surrey Wildlife

Trust, 2019). The information would then be geographically represented using heat maps to interpret positive changes.
    - Information from the monitoring schemes can be used to determine bioabundance (how many individuals are present of a given species), and biodiversity (how many types of species are present). Again, this information would be used to inform the success of habitat management measures, rather than establish KPIs relating to species. It would be assumed that habitats in good and very good condition would be more resilient to climate change impacts.
- Ensuring budgets at a national, regional and local scale incorporate the robust monitoring regimes. This can be undertaken on a five- or six-year cycle; however these must be undertaken and results reported to Natural England on an annual basis. Consideration should be made to making monitoring and reporting on results legally binding. Robust enforcement powers should also be incorporated into the new Office of Environmental Protection to ensure biodiversity and ecosystem services objectives are being met.
- Targets should be informed by the best available science, and should be reviewed every five years, to reflect changes in climate chance adaptation and advances in science.

With the implementation of the measures above, regional difference would be accounted for as the focus would be on habitat condition which would be measured against set criteria, rather than feature-based monitoring.

Cost-effective monitoring is critical to the delivery of a robust monitoring programme. One key aspect of current monitoring regimes is that they are labour-intensive to undertake surveys, report etc. However, innovation in the monitoring sector is growing substantially and monitoring the ECN should reflect current advances in this field. Examples of measures that should be considered in designing a monitoring regime could include:

- Use of remote sensing has significantly advanced over the last few decades, and can be a very useful tool for monitoring vegetation, habitats and habitat diversity including collecting information on vegetation height, plant vigour, successional stage, water and nutrient stress, biomass and carbon content and in some cases presence of particular species (Lawley, Lewis, Clarke, & Ostendorf, 2016). Techniques can include aerial imagery, remote sensing by satellite and LiDAR (landscape relief attributes) assessments that allow for 3D assessments of habitats. Remote sensing should be a core of future habitat monitoring methods for an ECN. To ensure a consistent reporting of results and analysis is undertaken, a standard methodology needs to be developed. This would need to consider capabilities at a local, regional and national scale and ensure data collected, once analysed, can be used to determine whether existing land management measures are delivering the desired outcome for biodiversity and ecosystem services.
- Using pollen assessments to identify species diversity could be used to monitor changes in biodiversity, but also monitor the arrival of new species, reflective of climate change adaptations which plant species exhibit and also behavioural

observations in some bird species. This has been shown to be successful in monitoring Natura 2000 sites in Italy (Leontidou, et al., 2021). Use of honeybee pollen has also been shown to be an effective tool to complement vegetation monitoring (Schmidt-Lebuhn, Bovill, & Encinas-Viso, 2022).

- The planet is hugely diverse and whilst we've only recorded approximately 1.5 million species, it is likely that there are several million more (Sweetlove, 2011). When assessing impacts of development or land management measures, the focus is often on vertebrates, such as birds, bats reptiles, amphibians etc, however 95% of known animal species are invertebrates (Centre for Biological Diversity, Accessed in 2021). Declines in invertebrate species cause by anthropogenic actions (e.g., climate habitat and habitat loss, fragmentation and degradation) will have catastrophic impacts on the planet as they provide critical ecosystem services such as pollination (critical for the agricultural industry), decomposition of plant matter, fertilisation and soil health, and feeding other species in the food chain that also deliver important ecosystem services. Monitoring invertebrates using standard methods is very time consuming and requires technical expertise, which is limited throughout the country. Metabarcoding is an important method to monitor invertebrate populations cost-effectively (Kirse, Bourlat, Langen, & Fonseca, 2021). Developing a cost-effective and robust strategy to monitor invertebrates using metabarcoding allow a better understanding of the current invertebrate population, their spatial distribution and the importance of core, buffer and stepping-stone habitats with regards to their presence and distribution across the country.
- Capitalising on citizen science, local groups (e.g., single-species interest groups) and existing national monitoring schemes, wildlife conservation organisation, local biological records centres and existing monitoring schemes etc are critical for ensuring data are collected cost-effectively. A national approach to collecting information will ensure cost-effective delivery of habitat, species populations and ecosystem services monitoring.
- Information capture to ensure universal access to all monitoring data will facilitate the success of a monitoring programme. Several methods are currently available using GIS systems and various applications, such as LandApp. The latter has been developed specifically for farmers and links the data to current Higher Level Stewardship (HLS) and future Environmental Land Management Schemes (ELMS). It is understood that applications for UK habitat classification surveys and habitat condition assessments are also being developed.

Ecosystem function is defined as the biotic and abiotic processes within an ecosystem that drives ecosystem services (Leuzinger & Rewald, 2021). One of the likely changes to be experienced from climate change will be a natural northwards extension of species distributions into sites, regions and states that currently do not support them. This will be effective both inter- and intra-state; in England species restricted to habitats in the south of England will move north and colonise habitats that currently do not support these. The impact of non-native species is generally viewed as being negative, with positive outcomes being rarely reported. Maintaining ecological functionality is critical to delivering on biodiversity and ecosystem services within an ECN. This would be achieved by establishing the key ecosystem services that habitats provide within an ECN,

understanding the ecological processes to deliver this service, determine the natural variations that would be expected to occur within the habitat, review how climate change will impact the habitat, and identify the measures required to incorporate resilience into the habitat.

As an example, particularly relevant to Surrey, lowland heathland is important for carbon storage, aesthetic value, recreational value and timber production (Cordingley, Newton, Rose, Clarke, & Bullock, 2015). Based on current models climate change is likely to impact heathlands by increasing the frequency and intensity of fires, which is linked to changes in hydrological regimes. Whilst fires are important for the ecological functioning of heathland, changes in frequency may mean that the habitats and species that live within these are less able to recover from one fire before being exposed to another, resulting in loss of habitat, biodiversity and ecosystem services. Numerous studies exist on the key factors that drive ecological functionality of heathland and this research can be used to focus monitoring regimes on existing threats so that management of these can be altered to drive resilience within these habitats.

# 5 Examples of Delivering Ecologically Connected Networks

Nationally, the Wildlife Trusts have been moving away from a site-based approach to conservation to a landscape approach, recognising this as being critical for nature's recovery. This approach is also being adopted by a number of Local and County Authorities. Below are two examples of approaches which could be taken to establishing an ECN.

## 5.1 Nature Improvement Area Ecological Strategy (2017 – 2022)

This strategy has been developed for Birmingham and Black County (Birmingham and Black Country Wildlife Trust, 2017). The strategy involves identifying three broad categories across the county:

- Core Ecological Areas that include the areas richest in wildlife and also those that have been reclaimed by wildlife. These include SSSIs, SACs with monads that contain 28 or more axiophytes. Within these the focus is protection through proactive engagement with Development Control, supporting landowners to manage the land for biodiversity and encouraging sustainable use.
- Ecological Linking areas, which join core areas and are generally concentrated around wildlife corridors. These include all monads with 9 – 27 axiophytes and those that contain Local Nature Reserves and, Local Wildlife Sites. Within these the priority is to enhance the existing habitats and restore the sites.

- Ecological Opportunity Areas which are intensively used parts of the landscape, dominated by formal parks, open spaces, gardens, road verges and productive farmland. These include all monads that contain fewer than 9 axiophytes and do not have another designation. Within these, there are opportunities to create new sites to form a network of sites that species can use to move across the landscape.

## 5.2 Surrey's Biodiversity Opportunity Areas and Urban Biodiversity Opportunity Areas

In 2010-15 Surrey Nature Partnership developed Biodiversity Opportunity Areas with the aim of providing the basis for a landscape-scale conservation programme to eventually realise a fully effective ecological network throughout, and beyond, the county. This is currently being expanded to include the ONS-defined areas of urban land-use, providing decision makers and landowners with strategic, focussed areas where land management measures to improve biodiversity and ecosystem services need to be prioritised.

The Urban Biodiversity Opportunity Area project specifically models connectivity throughout existing green infrastructure, to identify barriers across the urban landscape, preventing the theoretical movement of species. This provides 'heat maps' of functional green infrastructure for biodiversity across all of Surrey's urban areas, connecting these into the 2010-15 existing 'rural' Biodiversity Opportunity Areas. The information will then be used by LPAs to develop their policies and recommendations for enhancing delivery of ecosystem services and biodiversity objectives within the urban realm, as re-development and regeneration opportunities, and access to nature programmes allow. The model has been designed to be replicable in other areas of interest and can be broadened to rural areas. In developing the model, protected areas have been used as core areas for prioritising land management measures to improve biodiversity and delivery of ecosystem services.

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