Nature Recovery Network Handbook

Summary

The Wildlife Trusts are calling for the creation of national networks for nature's recovery. These will need to be spatially planned so that action can be targeted to where it will be most effective to form an ecologically coherent, resilient network of sites that will enable nature to recover and thrive.

The Wildlife Trusts are working to secure nature's recovery on land and sea. Our vision is to see active recovery for wildlife happening across at least 30% of our land and seas by 2030. There is different legislation and policy supporting marine networks and the processes for marine recovery and terrestrial recovery will work side by side. The legislation that supports recovery at sea is already in place, with lots of work going on to secure implementation. The legislation for networks for nature's recovery on land is in development, with lots of work still to be done. This handbook sets out how The Wildlife Trusts can respond to the call for a Nature Recovery Network in England, and to the English legislative and policy changes. Of course, we want nature to recover everywhere and will include case studies on how this approach is being integrated across terrestrial and coastal boundaries.

The draft Environment Bill contains some requirements that will help achieve the 25 Year Environment Plan commitment for a Nature Recovery Network in England, and to be successful this legislation will need to be interpreted and delivered with ambition. The Wildlife Trusts are already demonstrating how networks for nature can be created; we want to respond to the opportunity provided by the Bill by setting out an ambitious and deliverable template for creating a national Nature Recovery Network. This handbook has been developed by the Trusts in England who have experience in ecological network mapping and planning. We aim to provide a consistent approach to the process of developing maps and the strategies for implementing them.

The handbook sets out criteria for mapping Nature Recovery Networks, and the process by which they should be developed. It describes the components of the network, and how these are identified and mapped and the data necessary to achieve this. The technical appendices provide greater detail.

We describe how the relationship between the Local Nature Recovery Strategies, proposed in the draft Environment Bill, and the Nature Recovery Network should work. We believe that Local Nature Recovery Strategies should draw many different sectors together to plan how to achieve nature's recovery locally and that, in combination with other mapped environmental information, the Nature Recovery Network maps will form the spatial plan that helps target their activity to contribute to the Network.

To enable this, it is important that we can demonstrate how the Nature Recovery Network can help those organisations to delivery their own aims and obligations. The handbook provides the rationale for how the Nature Recovery Network concept is especially relevant to development and land-use planning, agricultural land management, natural solutions to climate change mitigation and adaptation, and helping to tackle health inequalities.
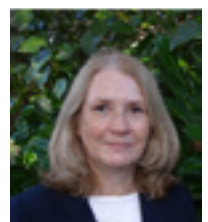
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Introduction

1.1 Our evolving approach to nature conservation

For years The Wildlife Trusts have been trying to stop and reverse the decline of wildlife. We haven't limited ourselves to one kind of wildlife, or certain areas. Instead our aim has been to protect all wildlife, all nature, everywhere and for everyone in the UK, for the future. And by nature and wildlife we mean the whole biosphere in which we live, animals, plants, trees, fungi, insects, soils and the minutest organisms within them, and the cycles of water, nitrogen and carbon that fuel every living thing. A tall order! Especially as, since The Wildlife Trust movement started, the pressures on the natural environment have become so great that the abundance of wildlife has more than halved, species have become extinct and, although we have done much to slow the rate, including protecting and caring for some of our rarest habitats and species in the UK, most of our wildlife continues to decline and we are now facing an ecological crisis.

We have long recognised that this is a problem that can't be tackled alone. We work with landowners of all kinds, especially farmers and developers, with local communities and local authorities, and with many different organisations. Together we have cared for and improved wild places, restored and created new habitats, helped to make farmland more wildlife-friendly and brought nature into the places people live and into urban parks and other greenspaces in their neighbourhood. This is our Living Landscapes approach to creating more space for nature. In doing this, we are also helping nature to help people — for example enabling healthier lifestyles, reducing flood risk or severity, boosting pollinators, capturing and storing carbon to help to tackle the climate emergency, and adapting to the climate change that is happening now.

Living Landscapes are what we do to restore the fortunes of the natural world, to help nature recover. This is both an approach to nature conservation — inclusive of both those who own and manage land and those who use and enjoy it — and a way of focussing our efforts. Across The Wildlife Trust movement there are more than 100 Living Landscape schemes which are bringing people together to extend and reconnect the fragmented remnants of nature over large areas. Natural England has recently published their *Nature Networks Evidence Handbook*[1]. It provides a very useful, clear and scientifically-based step-by-step guide to establishing and delivering landscape-scale initiatives that, like Living Landscapes, will contribute to the Nature Recovery Network.

Science has shown that nature has more chance of surviving environmental pressure and thriving, the more space it has and the more it is connected[2]. This means that nature needs more, and bigger places to live, these need to be better managed to enable species to thrive, and they need to be joined up to create a working system. The depletion and fragmentation of our natural environment has disrupted the balance of nature, encouraging a few species to flourish whilst many more decline. In most places we have to actively manage sites to maintain healthy wildlife populations, and prevent species being lost or others becoming damagingly invasive. By making sites and groups of connected sites larger we can restore some natural systems and might enable a less interventionist, and perhaps more spatially targeted, style of nature conservation management.

Through a Living Landscape approach, The Wildlife Trusts have been doing this, but there is no denying that wildlife continues to decline. The current ecological crisis is linked to the climate emergency. Damaged nature releases carbon into the atmosphere, and the habitats that could help to capture and store carbon continue to be degraded. Large-scale action for nature's recovery is needed but we face barriers to this in terms of resources, a lack of willingness by many organisations to take action, and government policy and economic imperatives directly causing damaging practices that harm wildlife and damage nature. If nature is to recover, a Living Landscape approach must be applied everywhere and this will take coordinated effort. The Wildlife Trusts' contribution to delivery of the Nature Recovery Network will be their Living Landscape schemes (or the Living Landscape approach that they take to their work for those that do not have focal schemes) but The Wildlife Trusts cannot effect nature's recovery through their schemes alone — everyone needs to help to deliver a national Nature Recovery Network.

This is why The Wildlife Trusts are calling for new legislation that supports the creation of a Nature Recovery Network. This joined-up system of places important for wild plants and animals, will in time become part of a visibly wilder landscape, a place in the real world. A delivery plan is needed for how to achieve this, guided by a map to show where and what needs to be done to enable nature to recover.

1.2   What is a Nature Recovery Network?

A Nature Recovery Network is a joined-up system of places needed to allow nature to recover and thrive. It is a combination of the existing places where wildlife is more abundant, and the places where habitats need to be restored or created in order to expand and connect the remaining fragments so that nature can recover. To be effective, it must extend across every part of England, including rural areas, coastal sites, towns and cities, and connect across boundaries with similar initiatives in the other UK countries and with the existing network of Marine Protected Areas. We want to see at least 30% of land managed to benefit nature to reverse declines, restore abundance and contribute to nature's recovery (see Appendix 3).

The network will provide more space for wild species to live, feed and breed. It will allow plants, animals, seeds and spores to move more easily from place to place, enable natural processes such as pollination and seed dispersal to happen between these places, and nutrient and water cycles to work effectively. It will help the natural world to adapt to a changing climate and other pressures on the environment. Natural places where wildlife is abundant and where such ecological processes work well are vitally important for both the biodiversity they sustain and the benefits they provide to society.

A Nature Recovery Network will work best when it is:
- evidence based,
- locally developed and nationally connected,
- statutory,
- spatially planned,
- our collective responsibility.

Through a series of internal workshops, we identified a number of opportunities and issues that need to be addressed to successfully develop and implement Nature Recovery Networks.

This Handbook draws on the expertise from across The Wildlife Trust movement in planning and implementing networks for nature, to suggest a consistent process for developing a Nature Recovery Network.

At present it is provided for England only, partly in response to English legislative changes and policy. It is complementary to networks for nature's recovery currently being developed in the Devolved Administrations.

RACHEL SCOPES

Why do we need a Nature Recovery Network?

2.1 The problem we need to solve

A healthy natural environment is valuable in its own right and is the foundation of our wellbeing and prosperity. But nature is in decline: numbers of many species are in freefall; rich wildlife habitats are fewer, smaller and further apart than they've ever been; and many are damaged by poor management, neglect, inappropriate development, pollution, or disturbance and can be negatively affected either directly or indirectly by the effects of surrounding land use. This reduces nature's resilience to environmental pressures, including climate change on land and at sea. We are also witnessing declines in natural capital, such as the loss of fish stocks and pollinators, and the loss of water-retentive habitats, which will have substantial economic impacts. Barriers preventing access to, and connection with, nature have had detrimental impacts on our physical and mental health. These impacts will continue to increase until we secure nature's recovery.

Conservation practice originally developed with a focus on preserving nature reserves, protected areas and threatened species. It has largely safeguarded many aspects of the natural world that would otherwise have been destroyed, and reduced the rate of wildlife losses in some areas. But we know that protected sites alone are not enough to achieve wildlife's recovery[3] and have long advocated a landscape-scale approach to conservation. Despite that, wildlife continues to be forced into fewer and smaller pockets of wild space, surrounded by intensive agriculture or urban development. We can't wait for a species to become threatened before valuing it enough to protect it. We are experiencing an ecological crisis and to recover we need to protect and provide space for all species.

The Wildlife Trusts have been articulating and demonstrating for many years what needs to be done to bring about nature's *recovery*. With such ideas now being embedded in new Government policy and legislation and supported by a growing evidence base and public interest, it is time for a step change in nature conservation in the UK. One in which the value and benefits of a healthy, wildlife-rich natural world are more widely recognised and reflected in the decisions made by governments, businesses, society and other organisations. We know what needs to be done to bring our wildlife back and how to improve our air, soil and water quality and to reduce pollution. We also know that these actions would have other benefits including helping reduce the negative impacts of floods, storing carbon, securing future food supplies, and improving our health and wellbeing. But, as a society, we are not addressing this in a strategic or coordinated way. We need a shared vision in the form of a National Nature Recovery Network.

The current systems and plans affecting how we use land were introduced separately over many decades. They have been amended, modified and changed to respond to different threats, opportunities and societal needs but were never designed fundamentally to achieve nature's recovery. Nor do they allow for confident, targeted, long-term alignment of decision-making, spending or investment for nature across government and wider society. Nature's recovery will only happen in practice if there is strategic, integrated planning and regulation, spending, investment and action in specific places, over a sustained period of time over the entire country.

The same is true in our marine environment, where we have a growing network of Marine Protected Areas. If these areas continue to be managed solely through a features-based approach, without considering the function of the network as a whole and the ecological connections between the individual protected areas, we will fall foul of the same issues of fragmentation and isolation that have contributed so significantly to the decline of the natural world on land. The whole marine network should have a recovery objective, especially an overarching aim to deliver Good Environmental Status, and must be effectively managed and monitored if it is to achieve and maintain recovery goals.

2.2 A spatially planned Nature Recovery Network

The Environment Bill will require national targets and interim milestones to be set. Those targets should encompass increasing the area of wildlife habitats and the diversity and abundance of species, and improving the quality of our air, water and soil. To meet these and for nature to recover, we need more places where wildlife can thrive and these places need to be bigger, better, and more joined up. To secure nature's recovery in practice, it is not only important to consider **what** action is needed, but also **where** it is needed and at what scale — where action for nature will be most effective to form an ecologically coherent, resilient network of sites that will enable nature to overcome pressures, thrive and adapt to an uncertain future climate.

There is a real need to coordinate and integrate decision-making affecting nature and places so that decisions about what happens on farmland are not made separately from decisions about our rivers, where we build houses or roads or provide equal societal access to nature for health and wellbeing. Plans for pollinators, the good ecological status of water bodies, or the condition of Sites of Special Scientific Interest should not be considered separately from the plans for nature's recovery. This will require coordination across Government departments too.

Where we live in relation to wildlife also matters if we are to be more connected to nature, healthier and happier. Nature's decline is leading to diminishing benefits for communities and individuals alike[4]. Access to nature improves physical health and mental wellbeing. Communities need wildlife-rich natural spaces near where they live and work so they can easily access them. Providing equal access to nature through positive planning will help reduce health inequalities and deliver the health benefits gained by nature's recovery to many nature-deprived communities.

Without a common vision, supported by legislation:
- we cannot hold to account those who may prioritise short-term financial return over long-term sustainability, but who may have the biggest potential to avoid or minimise damage to the natural world and help it recover;
- businesses with most to gain from nature's recovery (such as insurance firms or water companies) will continue to lack the confidence to make major long-term investments;
- organisations and funding bodies already dedicated to help achieving nature's recovery won't know where to invest their efforts most effectively and will lack confidence that the efforts of others will join up with and complement their own.

A spatial plan for nature will act as the evidence to inform strategies that set a framework within which decisions about housing, infrastructure, land management and conservation can all take place; guiding investment in nature to the places where it will have the most effect.

JAMES ADLER

2.3 The space nature needs

On average, well-managed, semi-natural habitats that are in good ecological condition need to cover at least 30% of the landscape to provide an ecologically coherent and functioning network (see Appendix 3 for references). This means, for nature to recover, we need around four million hectares of semi-natural habitat in England compared to the 1.7 million hectares we have currently [Figure 1].

Both physically connected habitat and functionally connected habitat (areas near enough to each other for species dispersal and other natural or ecological processes to work) make up an ecological network. Habitat does not need to be evenly distributed, but it is important that the matrix within which semi-natural habitat is located is not hostile to nature. New habitat needs to be created or restored where it will make the greatest contribution to the intactness of the network. In this way it will be most likely to succeed and become biologically diverse, colonised by a full complement of species that are characteristic of the habitat. Bigger sites should make up much of the network, with the remaining percentage intermingled with other land-uses. It will also be important to consider, where possible, how investment in new habitat can provide additional benefits to society (e.g. through the provision of ecosystem services such as flood alleviation, water purification, carbon storage, or access).

What will this look like in practice? It will mean getting existing protected sites and Local Wildlife Sites and other existing priority habitat into good condition for nature, restoring peatlands and creating new wetlands and saltmarsh, extending and connecting woodlands and scrub through natural regeneration and targeted woodland creation, and creating new species-rich grasslands and a host of other habitats. We need to see significant changes in the farmed environment. All farmland should be managed in a more sustainable way, that benefits those species associated with arable and other productive habitats. This will include things like reduced use of pesticides and sustainable management of soils, as well as the creation of wildlife habitat features that farmers are already encouraged to do. In farmland that falls within the nature recovery network, there should be ambitious targets for habitat creation and a percentage of land to be managed for wildlife, so that large swathes of connected habitats are created (see Section 6.1.3). In urban areas, wildlife-rich green

Land cover in England 13,039,500 ha

Current Protected Sites and Local Wildlife Sites **13%**

Additional land for Nature Conservation in 25 YEP **4%**

Extra land needed for 30% Semi-natural cover **13%**

Remaining land area of England 9,127,650 ha **70%**

At least 30% needed for nature 3,911,850 ha
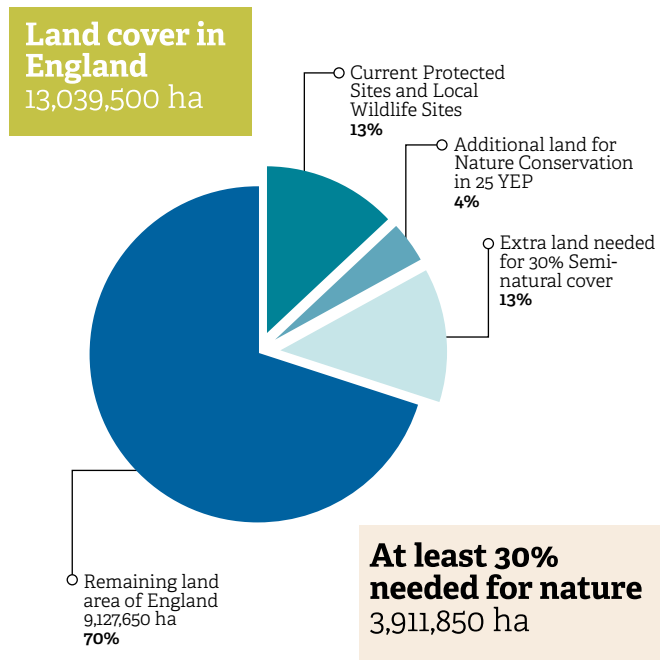
Figure 1: The space nature needs

spaces of all kinds already form wildlife corridors and stepping-stones and this network should be strengthened through new habitat creation, and more sites being brought into wildlife-friendly management.

The network for nature that we want to cover at least 30% of land will be found everywhere — in the mapped Nature Recovery Network and the surrounding landscape. It will form a net of nature across the whole landscape, rather like lace, in some places spread thinly so that the predominate land use shows through, in others the pattern of nature is clustered and coalesces into large areas dedicated to wildlife. All land should be managed sustainably to help counter the ecological and climate crises.

Addressing the ecological crisis in England alone will require a huge change in the way land is managed. But, in the 25 Year Environment Plan, government has only committed to create 500,000 hectares of new habitat — just a fraction of what is needed. We need a far more ambitious solution. In England, by 2030, we need:
- to create at least an extra two million hectares of new habitat,
- to manage existing habitat better to improve its quality for nature and
- to manage all land in an environmentally sustainable way.

2.4 A statutory Nature Recovery Network

To create the Nature Recovery Network, we need:

1. A national framework which sets criteria and guidance for the development of Local Nature Recovery Network maps and delivery strategies (i.e. Local Nature Recovery Strategies), to ensure consistent quality and compatibility, so that local maps can be combined to inform any scale of delivery, and add up to a national Nature Recovery Network. [*Draft Environment Bill Clause 96 (4) & (5)*]
2. A spatial plan: Local Nature Recovery Network Maps, developed in partnership, which identify accurately where existing wildlife habitats are now and where they should be in future to sustain a healthy, diverse natural world that is rich in wildlife and brings significant benefit to society. [*Draft Environment Bill Clause 97 (3)*]
3. Local Nature Recovery Strategies for delivering the Nature Recovery Network which draw on spatial information about ecosystem services, for example through a natural capital assessment, to enable opportunities for the delivery of multiple benefits to be identified, to provide the best value for time and money invested. [*Draft Environment Bill Clause 95-97.*]
4. There must be a statutory duty to create and implement these Maps and Plans. All relevant parts of local and national government should play an active part in developing and maintaining these Maps and Plans; to ensure that nature's recovery delivers the widest possible public benefit and to contribute to the implementation of delivery plans; [*Draft Environment Bill Clause 96 (1) & (2)*]
5. All public bodies must be held to account for their part in achieving nature's recovery. [*Draft Environment Bill Clause 93 (5) & Clause 95 (5)*]

The Draft Environment Bill contains requirements that support these elements, although much of the detail will be set out in statutory guidance or secondary legislation. The aim of Government is that the Bill supplements existing legislation and policy on protected sites and species and lays the foundation for the Nature Recovery Network. And to achieve this it is vital that the legislation is interpreted and delivered with ambition.

The Wildlife Trusts can help achieve this ambition by ensuring that the maps that are components of Local Nature Recovery Strategies provide a plan for an ecologically resilient and coherent Nature Recovery Network that connects across district, county and national borders. (See Section 4.1 on how this should be achieved).

Developing Nature Recovery Network Maps

This section sets out how the mapping of a Nature Recovery Network should be conducted. It enables a congruous approach to mapping Nature Recovery Networks across England (and, ideally, the UK), while providing flexibility to adapt to local circumstances.

3.1 Criteria for Nature Recovery Network maps

The following principles[5] should be considered when agreeing the local approach for development of the network.

1 **Map locally and in partnership but respond to emerging national frameworks.** To ensure consistency across the country, Nature Recovery Networks should be mapped based on an agreed national methodology (see following section). However, to ensure local ownership of local Nature Recovery Networks and to make best use of local data and expertise, mapping of Nature Recovery Networks should be carried out locally, funded consistently from national sources. Mapping should be conducted in partnership, engaging all stakeholders to ensure joint ownership and commitment.

2 **Base mapping on the best available evidence.** Mapping should be done using the best available evidence; the most accurate, up to date quantitative and qualitative information that meets an agreed standard. Any evidence gaps should be acknowledged and addressed. Network maps should be made to be easily reviewed and should be updated as a result of monitoring outcomes and as better evidence emerges.

3 **Build networks upon existing terrestrial habitats.** Nature Recovery Network mapping should initially be based upon existing natural habitats, which will act as the starting point for building a coherent ecological network.

4 **Reflect that nature's life support systems are foundational.** Nature Recovery Networks should be principally based on ecological connectivity, reflecting the fact that healthy ecosystems are foundational life support systems and that habitat connectivity is vital to achieving healthy ecosystems.

5 **Ensure cohesion and coherence across borders.** Collaboration should be undertaken between jurisdictive areas to reflect the fact that nature does not recognise administrative or ownership borders and to ensure that Nature Recovery Networks are coherent across political boundaries.

6 **Be designed to support viable populations.** Nature Recovery Networks should be mapped so as to be sufficiently extensive and inter-connected to support viable and thriving populations of native wildlife.

7 **Promote resilience and adaptability to a changing climate.** Nature Recovery Networks should be mapped considering the projected impacts of climate change and the importance of a permeable landscape to enable species to spatially adapt to climate change.

8 **Reflect that nature works at all scales and everywhere.** Nature Recovery Networks must be spatially comprehensive and present a coherent spatial vision for nature's recovery across the whole local area. If mapping is conducted at different scales, it must be complementary and fully integrated to ensure a coherent network.

9 **Be accessible, comprehensible and relevant to all stakeholders.** To reflect the importance of nature's recovery to everyone and the need to engage all stakeholders to achieve nature's recovery, Nature Recovery Network maps should be clear, concise and accessible to all stakeholders, including farmers, local planning authorities, government agencies, businesses, Non-Governmental Organisations, community interest groups and the public.

10 **Be designed to influence decision-making and facilitate long-term, efficient funding for nature's recovery.** Key stakeholders should be involved from the start in mapping Nature Recovery Networks, providing joint ownership. Nature Recovery Networks should be embedded in local, regional and national plans, policies and strategies to secure nature's recovery.

11 **Have measurable targets** set for successful implementation, against which progress can be monitored and assessed.

3.2 Developing local partnerships

Although Nature Recovery Network maps are based on ecological principles and identify what and where nature needs to recover, it is vital that a wider audience is engaged to secure delivery. In practice, developing the maps and consideration of the delivery strategy (see Section 4) will go hand in hand, and there is a value in understanding the local ambition targets and structure of the network and its implications for decisions from the outset.

Nature Recovery Network mapping will be required in order to inform Local Nature Recovery Strategies[6], which are to be prepared by Responsible Authorities. The draft Environment Bill leaves the identification of the Responsible Authority fairly open[7], and therefore the Strategies could in theory be developed at any scale. The Wildlife Trusts believe that Local Nature Recovery Network mapping initiatives and their strategies for delivery would be most effective if they are based on locally-identified need, knowledge, data and thorough consultation with local people and organisations.
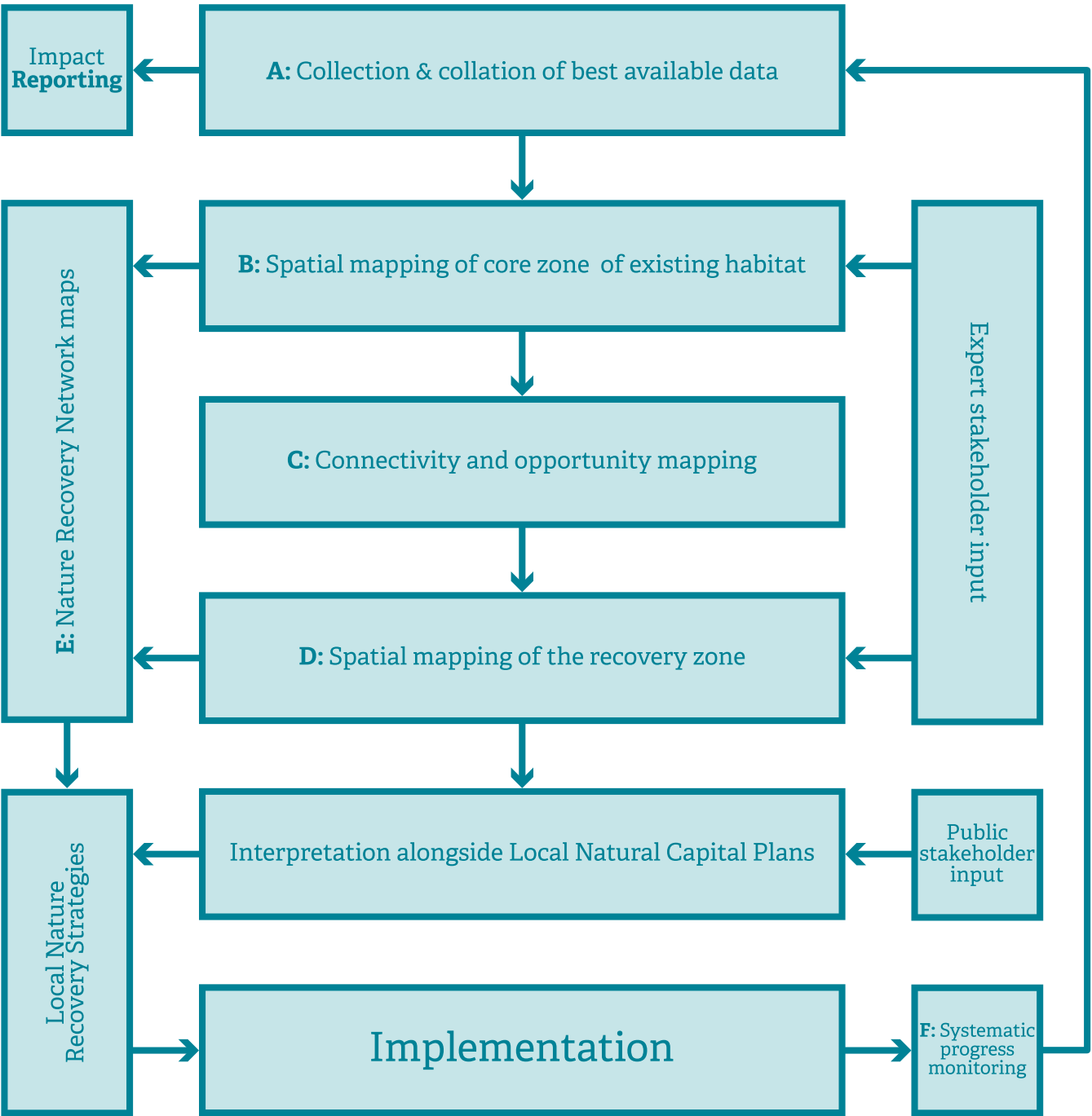
The Responsible Authority should be one with longevity, acting over a suitable scale, with democratic accountability. Local Nature Recovery Network maps need to enable the effective integration of decision making across public sector bodies. If they are to be used to target funding and influence land-use decisions it is vital that there is also a robust consultation process. The maps should be scaleable to local authority areas as this is the geographic sphere for land use planning of development. The planning process provides a ready-made public consultation system. These considerations suggest that in most places Counties and Unitary Authorities would be best placed to be the Responsible Authorities. This would also facilitate the partnership approach we are advocating in Section 4.2, as most Local Nature Partnerships operate at county level.

The flexibility of Geographic Information System (GIS) mapping means that once produced, maps can be aggregated to any scale to inform the decision making that happens on a wider scale (e.g. catchment planning or Environmental Land Management targeting).

The Responsible Authority will (we understand) be advised to form a Local Nature Recovery Partnership and in many areas this should be an existing partnership, such as the Local Nature Partnership, which can provide relevant expertise and breadth of membership to facilitate development and implementation. If all those organisations who will benefit from a healthier natural environment are to assist in helping nature to recover, it is vital that they are engaged from the start of the process. A partnership might include (but not be limited to) environmental NGOs, Defra family representatives, Local councils, landowner representatives, Catchment Partnerships, National Park Authorities, AONBs, Public Health Authorities, businesses and public access groups.

The diagram below [Figure 2] sets out the methodology diagrammatically and shows how the Nature Recovery Network fits with Local Nature Recovery Strategies (described in Section 4.)

Impact Reporting

A: Collection & collation of best available data

B: Spatial mapping of core zone of existing habitat

C: Connectivity and opportunity mapping

D: Spatial mapping of the recovery zone

E: Nature Recovery Network maps

Expert stakeholder input

Interpretation alongside Local Natural Capital Plans

Public stakeholder input

Local Nature Recovery Strategies

Implementation

F: Systematic progress monitoring

Figure 2: How the Nature Recovery Network fits with Local Nature Recovery Strategies

3.3 Developing local Nature Recovery Network maps
(see Appendix 1 for a more detailed description of the methodologies)

The following steps are recommended for mapping a local Nature Recovery Network.

A. Collection and collation of best available data

Maps should be prepared on the basis of the most accurate, up to date quantitative and qualitative information that meets an agreed standard. This would include local and national datasets, held by many different organisations and individuals. The majority would come from government departments and public sector agencies, Local Authorities, Local Environmental Record Centres and the National Biodiversity Network Atlas and significant nature conservation organisations and naturalist groups. In many cases, locally held data will be more accurate than others, but where local datasets are not available national data should provide a starting point. Where resources are available, consideration should be given to commissioning new data to fill gaps on land use and habitat cover. Maps should be updated iteratively when new data become available (see Appendix 2 for detail on data issues).

B. Spatially mapping the core zone

This zone should consist of existing core habitat of good value for nature — NERC Act Section 41 priority habitats including habitat matrices that are important for species abundance and diversity.

This can be identified from the UK Centre of Ecology and Hydrology Land Cover map, local habitat mapping where available and data from locally and nationally designated sites and should be classified using the UK Habitats Classification (UKHab) system (see Appendix 1). There need not be any differentiation between habitat within or outside of statutory and non-statutory protected sites for the purpose of understanding current connectivity and carrying out the modelling in the following stages. However, this information is important for delivery of the Nature Recovery Network, through the Local Nature Recovery Network Strategies. It will be useful to identify national conservation sites as defined in the (draft) Environment Bill, along

with Local Wildlife Sites (also known as Sites of Nature Conservation Interest). We recommend they are mapped as an overlaying GIS layer that can be switched on as needed.

C. Connectivity and opportunity mapping
(further detail is provided in Appendix 1)

Step 1: Create the base layer cover map

A complete land use cover habitat map is required for assessing and modelling connectivity and habitat opportunity mapping. We recommend UK Habitats Classification (UKHab) and that, as a minimum, a complete habitat map consisting of UKHab Level 3 data is required.

Step 2: Group main habitats

Once a complete cover habitat map is available, the next step is to group core habitats using the eight broad categories identified within the UK National Ecosystem Assessment with woodlands, grasslands and wetlands being key.

Step 3: Assess current connectivity

GIS tools such as cost distance analysis can show how well the existing habitat is connected ecologically for a typical species living in that habitat. This information can be used to identify where networks of habitats need to be protected from activity that might sever a core network, or as a basis for considering "quick win" opportunities. By re-running the connectivity modelling and varying the parameters (e.g. considering the dispersal abilities of more than one species and then run the analysis for each), it can also help to make decisions about where the greatest number of species could benefit from habitat restoration and creation.

Step 4: Identify opportunity areas

This mapping should be used to identify the best opportunities for habitat restoration or creation, incorporating prioritisation based on the Lawton Principles. Models are based on proximity to existing core habitat and/or an understanding of species dispersal.

D. Mapping the recovery zone

Because existing habitat patches are so fragmented, most computer-modelled connectivity maps identify the places with the highest potential to make significant contributions to existing habitat networks. This would not result in a functional Nature Recovery Network because it starts from a severely damaged, fragmented baseline. To achieve nature's recovery, and to enable nature to adapt to climate change, extensive areas of new habitat need to be created where there is now relatively little biodiversity value.

Both models we recommend help to identify the opportunity areas with the greatest potential to enhance existing connectivity and/or to expand existing networks. They can also highlight, visually, where there are gaps in the network, but do not identify where to prioritise new habitat beyond existing networks. Further work is needed to identify where to connect these in order to achieve nature's recovery.

To map the Recovery Zone, it is vital to involve local stakeholders. Opportunity maps for several smaller ecological networks (the existing fragments and their "dispersal areas", or a number of individual habitats) can be combined with local knowledge of other potential opportunities in one or more of the following ways, to identify the wider opportunities to join these up. Using:
- advice from local experts and stakeholder interpretation,
- conditional statements in GIS to assign a decision for a location based on the relative scoring of the multiple opportunity maps being compared, or
- other GIS modelling such as Condatis.

E. The Nature Recovery Network maps

The core zone and recovery zone, informed by the evidence from the connectivity and opportunity mapping alongside local expert and stakeholder interpretation, together form the Nature Recovery Network map. This will inform the priorities for conservation, restoration and creation of semi-natural habitat across an area to produce a more resilient and coherent network for nature.

It is important to recognise that the recovery zone on the map would show where habitat could be created, not where it must be created. Inclusion of land within this zone would not confer any obligation on the landowner; it identifies an opportunity that the landowner may choose to exploit.

It is vital that the Nature Recovery Network maps are easily understood and can be explained simply. The end product should be viewable and stored and shared in a way that enables the partnership access to and use of the same map. However, it may be that different levels of access are provided for different users (see Appendix 1 and 2). There should be a system of providing this information to people without access to the software. This must also address where the repository for all the data layers that are used in mapping are, and how people can access and edit these.

The resulting maps should be easy to read, with an end user being able to toggle on and off different types of layers. Some of the underlying data should be accessible to inform decision making (see Appendix 1 for details).

F. Update and review

The results of systematic progress modelling, and any additional data gathering, should feed into regular updates of the maps. While previous mapping exercises have tended to produce a static output which is difficult to update, the graphical modelling tools in GIS packages (e.g. Graphical modeller in QGIS and Model builder in ARCGIS) now enable the steps of the mapping process to be saved as tools which can be quickly re-run enabling the maps to be easily updated on a regular basis. A lead body or role should be identified for this to avoid confusion and provide a system of 'ownership' of the process (including a repository for the data and mapping layers).

The ability to update data and re-run analyses will also enable monitoring of changes in land use and achievement towards targets set within Local Nature Recovery Strategies.

3.4. Additional considerations

3.4.1 Species

The above process is based on habitat mapping rather than focusing on the conservation of specific species (key species and their populations might be used to set parameters for the connectivity model, but targeted species-specific conservation actions are not likely to be an outcome from the Nature Recovery Network mapping process). This enables a coordinated approach to nature's recovery by creating habitat networks of an extent that enables ecosystems to function. However, in some locations it may be appropriate to conduct modelling for specific species such as those associated with Ramsar sites and other sites of international importance, or those that rely on a much larger scale network. Locally important or at-risk species will need to be targeted through project-level mapping rather than the broader Nature Recovery Network mapping.

3.4.2. How Local Wildlife Sites fit in

Local Wildlife Sites are areas designated locally for meeting agreed criteria for their wildlife value. Arising from the application of planning guidance locally, systems vary across the country, but they consistently rely on sites meeting minimum standards, unlike the representative approach taken for statutory designation of nationally important sites (SSSIs). Therefore, some Local Wildlife Sites are of comparable quality with, or even better than, designated SSSIs and many are designated for being priority habitat.

Developed to help Local Planning Authorities meet their requirements to "Identify, map and safeguard components of local wildlife-rich habitats", the data behind these sites have been collected since the 1980s, through strategic surveying, local knowledge, field investigation and ongoing review. However, the extent to which all those aspects happens varies significantly across the country.

Although nationally generated data sets exist that also provide information on habitat quality, such as the Priority Habitat Inventory, those data sets are in many cases not generated by direct survey and have not been systematically reviewed against existing local data. The development of the Nature Recovery Network may well provide an opportunity to do that, and work is being trialled by Defra in the Ox-Cam Arc to establish to what extent remote data can inform habitat quality assessments.

As there is no national, systematic, ground-truthed survey of ecologically valuable habitat, in most counties the Local Wildlife Site data represent the best available knowledge of existing habitat quality. Data from Local Wildlife Sites will therefore have to form the backbone of the developing Nature Recovery Network, although the opportunity may exist to integrate Local Wildlife Site and Priority Habitat Inventory data during development of the Nature Recovery Network.

3.4.3 How we align over Devolved Administration borders

Cross-border alignment of networks across partnerships' jurisdictive borders is also critical to ensuring a coherent network for nature's recovery across the UK. Setting a principle whereby connectivity is mapped through an area, rather than to the boundary, would help with this. This would require collaboration with neighbours to identify potential targets for connectivity modelling into their area. However, there may be technical or licensing limitations when using connectivity models across boundaries. Additionally, work may need to be done locally to ascertain and address any issues with licensing that may prevent this overlap (for example, if purchasing of an additional Landcover map a new licence is needed to extend the network into a neighbouring authority). There may also be data licence cost issues preventing partnerships from doing more than minimal overlap, particularly if the purchase of the CEH Landcover map licence is required to complete habitat maps.

Alignment across borders is both a technical and policy issue. Across the England/Wales border for example, misalignment in policy-based priorities has caused issues in the past. Currently there is a huge opportunity to align priorities and produce cross-border integrated networks as Wales develops Area Statements and considers opportunities for ecosystem restoration. Network approaches are also being developed in Scotland (e.g. Central Scotland Green Network: Habitat Networks).

At all times, close coordination between neighbouring entities responsible for mapping local networks will be vital to ensuring alignment over borders; this coordination should start from the outset of mapping.

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Developing Local Nature Recovery Strategies

4.1 Local Nature Recovery Strategies and the relationship with the Nature Recovery Network

Effective delivery of the Nature Recovery Network will require action from numerous organisations and so the development of a multi-stakeholder plan for delivery is essential. The proposed mechanism for this is the Local Nature Recovery Strategy.

The Environment Bill includes a requirement for Local Nature Recovery Strategies to be produced that cover the whole of England. These strategies are to be prepared and published by a responsible authority and are intended to assist local authorities and other public bodies (including regional authorities) in identifying priorities and opportunities for conserving and enhancing nature.

Each Local Nature Recovery Strategy will include a map of existing areas important for nature (covering protected sites and wildlife-rich habitats) and will identify key opportunities for enhancement[8]. This, we argue, is the local Nature Recovery Network which, as set out above, consists of core nature habitats and the opportunities for nature's recovery.

As such, it is envisaged that Local Nature Recovery Strategies will act as delivery mechanisms for the Nature Recovery Network and will place local Nature Recovery Networks on a statutory footing[9]. At present the relationship between Local Nature Recovery Strategies and the Nature Recovery Network is not clearly defined in the draft Environment Bill and neither Defra nor Natural England has published details of how they expect this to work. It is vital that this legislation and subsequent policy and guidance work for nature's recovery. The Wildlife Trusts can demonstrate the ambition needed and show by practical example how the mapping referred to in the components of the Local Nature Recovery Strategy must plan an ecologically coherent network that will truly enable nature's recovery.

4.2 The role of the Local Nature Recovery Partnership

Working with Local Nature Recovery Partnerships would enable the Responsible Authorities to engage multiple organisations in the development of these Strategies. These could be the Local Nature Partnerships where these exist, and where a Local Nature Partnership does not exist, a similarly broad partnership group could be created that brings together organisations that should be involved in the delivery of the Nature Recovery Network. These could include the local Wildlife Trust, local and regional authorities, Defra family agencies, other environmental Non-Governmental Organisations, utility companies, public health representatives, the Local Enterprise Partnership for the area, and representatives of landowners. Any organisations that are not involved within the Local Nature Partnership and that will be critical for delivery of the Nature Recovery Network should also be engaged in this process. This work will require central government funding.

It may be useful to develop a framework that would allow different stakeholders to be involved or engaged at appropriate levels, based on their expertise, interests, or impact that the network would have on the way they use or manage land.

The Local Nature Recovery Partnership should establish principles for resolving conflicts and establishing priorities for habitat creation and for investment and delivery. Where it is possible to create more than one type of habitat within a connectivity or recovery opportunity zone, principles for deciding which to choose should draw on national and local priorities. A tool that could help do this is Systematic Conservation Planning[10], an approach which identifies priority areas for conservation action that complement existing protected areas, meet conservation targets whilst minimising costs and maintain connectivity.

There may be multiple public goods and services that could be delivered on any one site. Often these can be delivered together, for example recreation and occasional floodwater storage. However, some ecosystem services are mutually incompatible. For example, urban green corridors can provide access routes and play areas but that may not always be compatible with sensitive wildlife such as nesting birds and it may be important to ensure some greenspace provides more secluded habitat. Decisions should be made locally by the partnership, as they will need to reflect local circumstances and needs which may arise as a result of environmental, social, political or economic factors. The principles must be based on achieving the purpose and objectives of the Nature Recovery Network, to secure stakeholder commitment and confidence, and to ensure consistency while also enabling local variation.

4.3 Planning a strategy for delivering nature's recovery

The Local Nature Recovery Strategies should act as the strategic spatial planning framework to:

- Enable government, businesses, conservation bodies, communities, and land managers to more effectively co-ordinate action for the natural environment at local and national levels and help identify the optimal areas for investment in the natural environment.
- Integrate the planning and delivery of action for the natural environment with strategic action on wider environmental objectives that are dependent on changes in land use or management, to support the planning and delivery of:
  - Natural Flood Management and reduced diffuse water pollution,
  - Environmental solutions to water availability and storage,
  - Measures to reduce carbon emissions and increase carbon storage in natural assets (such as peatlands, woodlands and saltmarsh),
  - Habitat creation to mitigate negative impacts of poor air quality and
  - Better access to nature to reduce health inequalities.
- Provide a means of strategic planning for development that protects nature and enables net biodiversity and environmental gain to be designed and targeted in a way that will contribute to nature's recovery and provide the greatest benefits to society.
- Target Environmental Land Management schemes and payments to ensure they fully contribute to repairing and restoring natural systems.
- Initiate a new framework and impetus for local nature conservation efforts by land managers, communities and partner organisations.

The Nature Recovery Network maps would be the basis of the strategies, available as a single Geographic Information System (GIS) layer with detailed habitat information in the attribute table so that information can be accessed easily. These maps, initially developed at County/Unitary scale, would have national coverage and because they are in GIS format, could be combined or divided as appropriate to be used by stakeholders. This would enable organisations to use a Nature Recovery Map at the scale at which they operate.

In order to encourage delivery by a wide range of organisations it needs to be clear how these organisations will benefit from nature's recovery.

Information is needed about where nature can delivery benefits to people and society, so that opportunities to get multiple benefits from enhancing nature can be identified. This can be achieved through ecosystem service mapping, which is beyond the scope of this document, although some information is provided in Appendix 5.

The Nature Recovery Network map should be considered alongside ecosystem service maps to plan the activity that would both enhance the Nature Recovery Network and, where possible, improve each ecosystem service. This would ensure that the best opportunities were identified for activity to take account of wider benefits and increases value for money.

Local Nature Recovery Strategies should form an indicative delivery plan for each Local Nature Recovery Network map. They should set out the type of activity and the investment needed to contribute to delivery of the targets set for each of the core and recovery opportunity zones and in the wider rural and urban landscape outside of the network. They should show how the network can be delivered through focussed activity over a longer timeframe. Habitat restoration and creation and the recovery of species, including reintroductions, can be planned and delivered at a suitable scale (including across multiple local Nature Recovery Networks), guided by clear objectives.

In March 2020, Natural England published their Nature Networks Evidence Handbook[11]. There is detail within the handbook that will be useful for practitioners at this stage when considering the design and delivery of landscape-scale projects and addressing area-based restoration and creation. The NE document clearly sets out how to develop a shared vision, build a partnership, and then develop and implement a plan. It is very much about individual project-delivery at a landscape-scale and such projects are integral to the delivery of the Nature recovery network. It sets out a useful process that can be followed by the Local Nature Recovery Partnership and/or others involved in creating and developing landscape-scale initiatives.

It will be essential to monitor progress on the delivery of the Nature Recovery Network, and its effectiveness. The Local Nature Recovery Strategies should include the monitoring process for the Nature Recovery Network including indicators to measure success. (See Section 5 for further detail)

4.3.1 Translating national and local environmental targets into action.

Local Nature Recovery Strategies have the capacity to achieve huge value for society beyond the requirements set out in the Environment Bill. They should integrate delivery mechanisms from all sectors to achieve multiple benefits for people whilst addressing the fundamental problem of reversing the ecological emergency through:

- regulation for nature's recovery — targeting activity that results from legislation and is intended to control impacts on the natural environment, including, for example, the planning and control of development and targeting of biodiversity net gain payments;
- investment in nature's recovery — targeting financial investment in, for example, public health, education and recreation to generate positive outcomes for nature's recovery. A key element in this would be the targeting of agricultural payments for public goods and services (through Environmental Land Management);
- action for nature's recovery — as well as identifying priority areas for habitat restoration/creation/enhancement that will contribute to delivery of the Nature Recovery Network, the Local Nature Recovery Strategies should consider implementation and capture how partnership projects can contribute to delivery. They should aim to engage public sector organisations, businesses, communities and individuals to contribute to the Nature Recovery Network and identify the kinds of actions they could take.

TOM MARSHALL

For each component of the Nature Recovery Network, we provide an indicative framework for how regulation, investment and wider action could contribute to delivery of the network. Detailed criteria and plans will need to be developed locally with partners for delivery of the network. Each local Nature Recovery Network component would need to have explicit objectives to maintain or improve existing sites, restore or create habitat to expand and better connect existing sites, recover populations of threatened or re-introduced species and provide wider environmental benefits. (Section 6 sets out how the Nature Recovery Network can be used to support integrated policy delivery and how it supports and informs specific policy areas).

4.3.2 The core zone

This comprises the most valuable and important places for nature and is vital as the basis for ecosystem service provision. The focus for action in this zone should be on protection; better management; improving the condition of habitats; restoring natural ecosystem function; and with targets reflecting the 25 Year Environment Plan commitments, the new Nature Strategy and the Environment Bill. Targets should also be set to achieve the wider aims of the Nature Recovery Network and contribute to the achievement of Favourable Conservation Status for priority habitats and species.

Regulation: Well-designed rules and regulations are needed to protect core areas from habitat loss, pollution, or other damage. Local planning policies should have a presumption against development of core areas of Nature Recovery Networks, as required by National Planning Policy Framework paragraph 174. Thus, development should avoid damage to core Nature Recovery Network sites or increasing site fragmentation. Environmental Impact Assessment should be required for change of land use affecting core areas.

Investment in sites in the core zone should be used to improve management, aiming to bring sites into favourable condition to meet 25 Year Environment Plan and future Nature Strategy targets. (It is recognised that this will take longer for some habitats than others).

Action on sites in the core zones should improve the condition of the site for biodiversity, implementing a management plan that identifies what needs to happen to bring and maintain the site into favourable condition.

4.3.3 The recovery zone

Areas with a high priority for action
These are places identified through Nature Recovery Network mapping and modelling as the best places to restore and create new habitat to extend and connect the core areas. Targets should be set for a proportion (perhaps 60%, as this is the point at which woodlands and grasslands become most ecologically resilient[12, 13]) of the land in this zone to eventually be high-quality semi-natural habitat that in time becomes part of the core zone. There should be a high priority to work with landowners to identify areas for habitat creation and restoration.

Regulation: local planning policies should recognise the potential of land in these zones for contributing to Nature Recovery Networks, which should not normally be considered for development. Payments from developers to deliver offsite Biodiversity Net Gain should be targeted for spending on habitat creation and restoration in these zones, particularly if development occurs within the Nature Recovery Network.

Investment: Some habitat creation and restoration could be funded by targeting Environmental Land Management payments for public goods and services. Ecosystem service maps can be overlaid to understand where society and business would benefit from (or need) more resilient ecosystems, and this enables both public and private sector investment to be targeted to create and restore habitats that contribute to achieving their own aims whilst helping nature to recover. Grant giving bodies could have confidence that funding spent in these areas provides high value, sustainable outcomes.

Action in this zone should include:
- Working with landowners and providing advice on opportunities and incentives for habitat restoration and creation,
- Assessment of ecosystem service provision, and developing partnerships with the beneficiaries of these services, or the public bodies that serve them, to fund and implement projects that will create new habitats to improve the services to people and businesses.
- Development and delivery of biodiversity-led projects to extend and connect nature through restoring and creating new habitats.

<u>Areas with a medium priority for action</u>
This is the potential network opportunity area which is more ambitious than the immediate colonisation and dispersal-based opportunities, and builds out from these, connecting the existing fragments and their "dispersal areas" into one whole network. Targets should be set for 30% of the land identified in this zone to eventually be high-quality semi-natural habitat that in time becomes part of the core zone. 30% is suggested by some scientists as the level of coverage needed to achieve minimal habitat isolation[14, 15].

While the primary focus of the network as a whole is nature's recovery, its objectives also include wider environmental and socio-economic benefits. Thus, individual areas may have an additional focus on changes in land use or management to restore natural capital assets to enhance ecosystem services or create new opportunities for access and recreation. A habitat and wildlife benefit would normally be expected through such land management measures and the ensuing extension of the network, but in this zone it may not be the main objective because providing biodiversity targets are met, not every land parcel within this zone has to have nature conservation as its primary function. Similarly, public access to high quality greenspace for recreation and health might be a determining factor in the development of the network in urban and peri-urban areas.

Regulation: Development in the recovery zone should be designed to incorporate a high proportion of natural greenspace to deliver better ecological connectivity and everyday access to nature for residents and local people. It should meet or exceed the highest environmental standards in place at any time, including BREEAM; the (forthcoming) British Standard for Building with Biodiversity; and Access to Natural Greenspace targets.

Investment: Some habitat creation and restoration could be funded by targeting payments for Environmental Land Management. Ecosystem service maps can be overlaid to understand where society and business would benefit from (or need) more resilient ecosystems, and this enables both public and private sector investment to be targeted to create and restore habitats that contribute to achieving their own aims whilst helping nature to recover. In particular, investment in natural solutions to climate change, particularly creating new habitats for carbon-capture, will achieve real progress in creating a broader

network for nature's recovery. Grant giving bodies could have confidence that funding spent in these areas provides high impact over a wider area with multiple beneficiaries.

Action in this zone should include:
- working with landowners and providing advice on opportunities and incentives for contributing to delivery of the Nature Recovery Network;
- assessment of ecosystem service provision, and developing partnerships with the beneficiaries of these services, or the public bodies that serve them, to fund and implement projects that will create new habitats to improve the services to people and businesses;
- seeking opportunities, including through off-site delivery of biodiversity net gain, for large-scale habitat creation such as new wetlands, woodlands and rewilded areas;
- connecting nature through restoring and creating new habitats throughout the rural and urban landscape, including new habitat patches, linear features like hedges, roadside nature reserves, riparian corridors, greenways, and smaller features like ponds, copses, churchyards and the larger Sustainable Urban Drainage Systems;
- green bridges should be part of transport infrastructure projects;
- buffer zones to protect core and newly created areas from environmental impacts or to target measures restoring ecosystem function such as hydrological processes.

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4.3.4 Beyond the Nature Recovery Network

Areas scoring low in the connectivity modelling
The Local Nature Recovery Strategy should also consider the management of land within the wider landscape, which will be important in supporting the Nature Recovery Network. The wider landscape will need to be wildlife-friendly and permeable to species and to be able to maintain ecosystem services. Sustainable land use and business practices, in rural and urban areas, should include nature-friendly measures that ensure that wildlife can thrive everywhere. Current Agri-environment schemes and future Environmental Land Management will be important for ensuring wildlife opportunities, particularly for species that rely on the farmed environment. Incentive payments should also be used to tackle issues such as soil erosion and loss of pollinators across the farmed landscape.

Some of the greatest future gains for nature will be made where new habitats are created across big areas that currently support limited wildlife. Ambitious projects like the Great Fen in Cambridgeshire, which is connecting isolated habitat areas across intensely managed farmland through newly created habitat, or the Knepp estate which is rewilding 3,500 acres of arable landscape in Sussex, might not have been prioritised by connectivity mapping but will deliver an abundance of wildlife and other environmental benefits. It is important that any strategy for nature's recovery is flexible and enables opportunities for habitat creation on this scale to be realised. Nature Recovery network mapping can be used to identify how to connect projects like these into the network.

Regulation: Development that has no significant impact on the natural environment in urban areas can nevertheless deliver a net gain for biodiversity through Urban Greening Factors, which can result in tangible contributions to a Nature Recovery Network. It is vital that key biodiversity sites, SSSIs, Local Wildlife Sites and priority habitats outside the Nature Recovery Network continue to be protected.

Investment in natural solutions to climate change adaptation in this area could make a huge contribution to nature's recovery and should be designed and managed to enhance wildlife.

Action in this zone would include activities undertake by individuals, businesses, schools, NGOs and public bodies. For example:
- road verges could be managed for wildlife by mowing later in the year and removing the cuttings;
- in urban areas, new parks, street trees, green roofs and walls will be important to help everyone experience and access nature. Amenity and recreational areas should be managed to enhance wildlife. Action for nature should be targeted where it will reverse poor access to nature and help address health inequalities;
- creating and managing hedges, ponds ditches, field margins and trees on farmland will help to provide a network of habitats for farmland wildlife.

Monitoring and Evaluation

The Nature Recovery Network is an ambitious and radical re-shaping of nature conservation for the 21st century as a joined-up, interdisciplinary approach. Evaluating its success dictates that monitoring must be similarly joined up, and standardised. In order to assess the success or otherwise of Nature Recovery Network mapping, Local Nature Recovery Strategies and the resulting interventions, it is important to assess biodiversity trends over scales at which Nature Recovery Networks are being developed. Efforts to monitor biodiversity over landscape scales are not well developed, being intermediate between existing national surveys and site assessments. National biodiversity trends are too generic to be scaled down from large-scale citizen science surveys such as the British Trust for Ornithology's Breeding Bird Survey without introducing bias. Conversely, resources are not available to allow the detail of small-scale site-based biodiversity assessments to be scaled up to a landscape level.

Any monitoring to assess conservation interventions or biodiversity trends over a whole landscape will inevitably be carried out at different scales, from site-based condition assessments to wide-scale remote sensing. Therefore, monitoring protocols and data need to hold attributes which bridge this gap and allow a landscape assessment to be made. For this, a spatial data set is a powerful attribute that allows seemingly unrelated data to be nested together at hierarchically increasing scales.

Single species atlases have utilised the Ordnance Survey grid system at local, regional and national levels. With the functionality of Geographic Information Systems, Ordnance Survey grid squares can move on from single species distribution mapping to the representation and analysis of any combination of landscape, species and habitat attributes or variables. Grid squares can be used to sample the landscape in question and scale-up for national assessments. For example, Gloucestershire Wildlife Trust have now used grid square mapping to monitor the condition of their nature reserves for several years and have helped several other Wildlife Trust implement this system.

Grid based mapping, alongside heat mapping of results, produces an understandable, cost effective, adaptable and rapid approach to monitoring. A group of Wildlife Trusts is now collaborating to see how grid-based monitoring can be used to sample landscape scale monitoring attributes and there is ongoing work to develop a monitoring framework based on the Lawton principles of bigger, better, more, and joined, using approaches relevant to the appropriate scale and available resource. Broad techniques to monitor each of these themes are emerging, with three relating directly to work on the Nature Recovery Network mapping.

Monitoring requires structured, repeatable protocols to be put in place to assess ecological or structural features, such as a target species or habitat. Measurable attributes for each key feature are then produced and monitored which have upper and/or lower trigger points, which precipitate action should these not be met. For example, when monitoring a feature such as a species rich grassland, attributes such as a range of positive and negative indicator species may be chosen, with upper and lower targets produced based on how many indicator species would demonstrate the site is being managed appropriately.

More: is more land being managed for wildlife? This theme can be monitored using a mapping exercise that tracks changes in hectarage in conservation land management including agri-environment schemes and the future Environmental Land Management Scheme, land being managed for wildlife through biodiversity net gain in the planning system, Local Wildlife Sites (in positive conservation management), Non-Governmental Organisation nature reserves etc. The baseline Nature Recovery Network maps developed would provide the lower trigger points for monitoring, in that the hectare measurement of sites in positive management would provide a threshold figure that as a movement or individual Wildlife Trust we would not want to go below (as this would mean less land is being positively managed than before the mapping exercise).

Bigger: are the sites we manage bigger? There may be more managed for wildlife, but are these sites bigger, or are we managing a lot of small sites? This is a simple exercise of dividing the hectare measurement from above of land in positive management, by the number of sites managed. Again, the first measurement of this taken in the original process of creating a NRN map and Local Nature Recovery Strategy can provide the lower trigger point.

Joined: connectivity modelling can be used to produce a numeric output for functional connectivity in the mapped landscape, which could be used as a metric to assess connectivity. Through regular reassessment of the Nature Recovery Network, this metric can be compared to previous mapping iterations. Targets on lower limits of connectivity should be created as part of work to develop Local Nature Recovery Strategies, providing trigger points for action. Modelling needs to be validated with field data to assess the assumption that theoretical connectivity translates to functional connectivity; species and processes tangibly moving through landscapes. Kent Wildlife Trust's Nature's Sure Connected project[16] has developed a practical field survey approach to assess functional connectivity using indicator species.

As such, it is possible to assess these three themes at a landscape scale, based on outputs from Nature Recovery Network mapping. The final two themes are not achievable from the Nature Recovery Network mapping as it stands but are important to deliver a full assessment of biodiversity at a landscape scale. Both themes are still under development.

Better: this theme focuses on habitat quality. Some Trusts (e.g. Devon Wildlife Trust) are developing a method using remote sensing to assess habitat quality and structure. Sheffield and Rotherham Wildlife Trust's More Data for Nature project is trialling a different approach. The project is rolling out site-based surveillance at a wider scale, working with local groups across the network, and aiming to pull this into one final metric assessing site quality at scale. In the long term, if a habitat quality score could be integrated into the complete habitat cover map, progress on improving habitat quality could be assessed periodically across the whole country.

Species: this additional theme focuses on species level assessments, i.e. species richness, abundance or distribution. Fundamentally, the only proof that the Nature Recovery Network is working will be direct evidence of an increase in wildlife. Selecting a range

of individual indicator species to accurately reflect biodiversity trends for a landscape will be challenging, particularly given changes in distribution and behaviour due to climate change. Therefore, a suite or group of species could provide a better, more flexible assessment. This theme is not well developed currently, however projects such as Sheffield and Rotherham Wildlife Trust's More Data for Nature project, and Kent Wildlife Trust's Nature's Sure Connected project are working to develop suitable methodologies.

Much ecological monitoring has failed due to a lack of clearly defined questions and/or resourcing. However, all monitoring fails if it is not measured relative to a clearly defined baseline. It is therefore of paramount importance that standardised surveillance is planned at the beginning of a Nature Recovery Network development and that the basis for evaluating their effectiveness is clearly articulated at the outset. It is often overlooked that baseline data need to be gathered prior to intervention and monitoring designed such that ongoing data collection is agreed and resourced to ensure the essential measurement of changes and impacts. As such the Wildlife Trust movement, as well as developing a common approach to Nature Recovery Network mapping, should work to develop a common approach to landscape scale monitoring, building on the work of Kent, Gloucestershire, and Sheffield and Rotherham Wildlife Trusts.
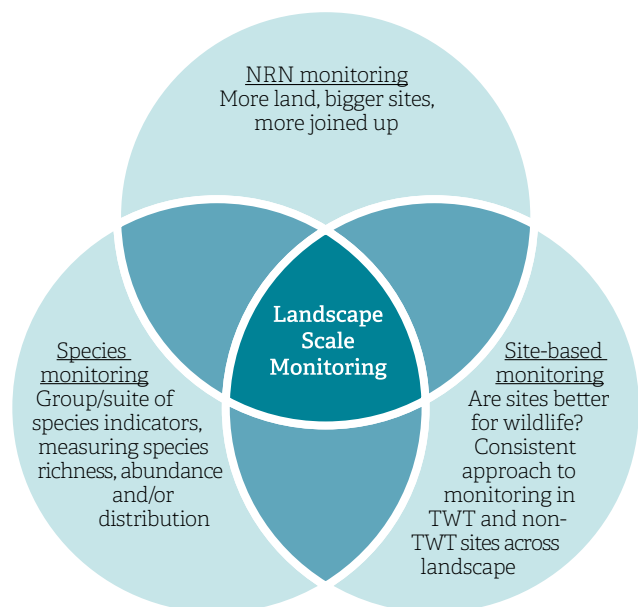

Figure 3: Landscape-scale monitoring diagram

Policy to Practice

6.1 Supporting integrated policy delivery

The Nature Recovery Network must form the overarching framework for a number of elements of government policy and legislation. As a spatial vision to enable nature's recovery it is a vital tool to improve the ecosystems on which society depends. The Nature Recovery Network should provide the spatial framework for delivery of ambitions, commitments and targets set out in the Environment Bill, the 25 Year Environment Plan and the Nature Strategy. It should guide delivery of any policy which has a spatial element and requires activity which may affect the natural environment.

A healthy natural environment is essential if society is to benefit from the services nature provides, so nature's recovery should be at the heart of decision-making, but there will often be opportunities to achieve multiple benefits from individual actions. This will be more effective if delivery is strategically planned. The Nature Recovery Network can help to plan the delivery of activities required by a range of policies in an integrated way, including Biodiversity Net Gain (see Section 6.1.1) and the proposed Environmental Land Management Scheme (see Section 6.1.4), so that the most effective action is taken in the right place. It can provide evidence to inform land-use planning, including development and infrastructure planning, green infrastructure strategies, River Basin Management Plans, Rights of Way Improvement Plans, National Park and Areas of Outstanding Natural Beauty Management Plans, Local Natural Capital Plans and Strategic Economic Plans. It can be used at a range of scales, to inform site management plans, to develop landscape-scale projects and to target funding streams, grants and charitable funding and, through ongoing monitoring and update, could also be a tool to evaluate success. The Nature Recovery Network also enables Local Planning Authorities to formally recognise features in the landscape that do not have any formal or statutory designation. This helps to meet the current obligations under national policy to identify and support ecological networks. Those sites that may be important for their connectivity value and/or as future opportunities for restoration can be recognised and defended through identification in the Nature Recovery Network.

Set out below are some areas where the Nature Recovery Network concept is especially relevant.

6.1.1 Embedding Nature Recovery Networks into Local Development Plans

Within the National Planning Policy Framework (2019)[17] there are several references to ecological network mapping and requiring the maps to be used in decision making. For example, paragraph 170 requires that planning policies and decisions should contribute to and enhance the natural environment including by "*minimising impacts on and providing net gains for biodiversity, including by establishing coherent ecological networks that are more resilient to current and future pressures*" (para 170d). Paragraph 171 requires that local plans should "*take a strategic approach to maintaining and enhancing networks of habitats*". In paragraph 174, the Framework also states that to protect and enhance biodiversity and geodiversity [Local] plans should:

A. *Identify, map and safeguard components of local wildlife-rich habitats and wider ecological networks, including the hierarchy of international, national and locally designated sites of importance for biodiversity; wildlife corridors and stepping stones that connect them; and areas identified by national and local partnerships for habitat management, enhancement, restoration or creation;*

B. *Promote the conservation, restoration and enhancement of priority habitats, ecological networks and the protection and recovery of priority species; and identify and pursue opportunities for securing measurable net gains for biodiversity.*

The Nature Recovery Network forms a key part of the strategic evidence base for local plans and associated policies and decisions that relate to land use planning and development. The Nature Recovery Network should therefore be incorporated into local plans and used to:

- Identify areas within the local plan area that are of especial importance within the context of the Nature Recovery Network, including: existing habitats that are of highest value, areas that buffer existing core habitat, and gaps within the existing ecological network that, if filled, would improve ecological connectivity.
- Assess, identify and prioritise opportunities for ecological enhancement through local plans and strategies.
- Identify the best sites for development and those areas where development should be avoided. Sites of core importance to the Nature Recovery Network (such as existing high-quality grassland,

semi-natural woodlands, wetland habitats etc.) should be protected and development should not result in severance of ecological connectivity within the network.

- Inform the design of the development in such a way that it makes a net contribution to the Nature Recovery Network (including through mandatory Biodiversity Net Gain, see Section 2).
- Inform and target biodiversity net gain delivery or similar greening metrics (as set out in paragraph 2.5.1 above).
- Inform the use of building standards that promote biodiverse developments within local plans (e.g. Building with Nature standards) to ensure that development targets action to most effectively contribute to restoring nature.

Any other regional or local spatial initiatives that are not within the remit of a Local Plan (for example, a strategic approach to transport or housing that cuts across multiple local authorities (e.g. Integrated Water Management Plans) should be informed by the Nature Recovery Network. These spatial strategies should seek to contribute to, rather than negatively impact on, the Nature Recovery Network, and the selection of sites for e.g. transport or housing developments should be informed by the Nature Recovery Network.

6.1.2 Biodiversity Net Gain for development

Defra's 25 Year Environment Plan makes commitments on net gain (Biodiversity Net Gain and wider Environmental Net Gain)[18]. Some of these are already well established in National Planning Policy. Further provision for Biodiversity Net Gain to be a condition of planning permission in England is being established through the draft Environment Bill. This means there will soon be a mandatory requirement for most development permitted under the Town and Country Planning Act 1990 to deliver a minimum of 10% biodiversity net gain.

Defra has developed a biodiversity metric tool for assessing and quantifying biodiversity loss and gain. The current version, Biodiversity Metric 2.0 is under review with a final version and accompanying guidance expected by the end of 2020. Further guidance on biodiversity net gain has also been published by CIEEM, IEMA and Ciria: Biodiversity Net Gain – Principles and Guidance for UK Construction and Developments. The application of the metric will need to be supported by local ecological expertise and data. Integrating the

use of Local Nature Recovery Network maps with the Defra Biodiversity Metric will, if done properly, help incentivise locational choices for development and biodiversity net gain in a way that supports nature's recovery. It will help ensure that development is located in places that avoid impact to important biodiversity areas; and ensure gains are targeted in the best locations to secure restoration and connectivity.

The concept of Environmental Net Gain is less well developed currently, but it is expected that development projects should eventually account for, and secure net gains in, wider natural capital, but which must be underpinned by biodiversity gains.

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There is a clear and vital link between imminent Biodiversity Net Gain and future Environmental Net Gain delivery and the Nature Recovery Network. Not only should the Nature Recovery Network guide development away from areas of sensitivity and maximum impact, it highlights areas of opportunity: where should net gain be delivered and what form should it take? One of the key considerations for any net gain delivery is whether it is on-site or off-site; in other words at the zone of impact or some distance away. Government has proposed a 'spatial hierarchy' to incentivise on-site and local gains where appropriate. This will be achieved through the design of the metric, as well as policy and guidance. But essentially, the approach taken should be the one that is best for biodiversity and leads to genuine and demonstrable gains in the long-term. To achieve its aims, Biodiversity Net Gain can only succeed if current protections for existing habitats are maintained, and net gain is only applied after negative impacts of development have been avoided or completely mitigated.

On-site Biodiversity Net Gain should harmonise with the features of the Nature Recovery Network, complementing it and adding ecological function to it. For offsite delivery the Nature Recovery Network is the obvious tool for guiding where this should take place and what form it should take. Furthermore, there is scope for meaningful and strategic pooling of Biodiversity Net Gain at scale within the Nature Recovery Network if it highlights opportunity. In the future, consideration could also be given to the strategic pooling of Biodiversity Net Gain and Environmental Net Gain and in some locations this is likely to be designed and delivered through a green infrastructure strategy. However, accounting would have to remain separate, to ensure delivery of Biodiversity Net Gains is always given precedence and to ensure that Environmental Net Gains are not used to offset biodiversity losses and/or gains. The long-term monitoring of Biodiversity Net Gain delivery should be coordinated with, and contribute to, monitoring of a Nature Recovery Network.

6.1.3 Environmental Land Management

The ability of land to provide public goods, including biodiversity, is highly variable, and depends on the existing condition and location in relation to other natural assets. Restoring a small area of isolated, species-rich neutral grassland will have a biodiversity benefit but, doing so in an area which provides a functional connection, or stepping-stone, for dispersal will have considerably greater benefits. The Nature Recovery Network therefore provides an opportunity to guide the application of public money to locations where the greatest public good can be delivered.

In the past, agri-environment schemes have been at various times either highly focussed (e.g. the original Countryside Stewardship Schemes or Higher Level Stewardship) or broad and shallow (e.g. the Environmentally Sensitive Area approach). However, both these approaches benefit from suitable targeting, albeit at different scales, and the Nature Recovery Network would facilitate this.

At the most basic level, the Nature Recovery Network could simply provide a backdrop for advice and support, with guidance and incentives for sustainable management practices targeted on the basis of habitat creation or network enhancement possibilities. For example, payments should aim to create healthy soils, and strong, abundant populations of pollinators everywhere. Additionally, the Nature Recovery Network could feed into definitive targeting of payments, with payments for some activities guided by the Nature Recovery Network.

We envisage the Nature Recovery Network developing alongside the emerging Environmental Land Management schemes, and Environmental Land Management adapting to apply the Nature Recovery Network to targeting as it becomes available. In the wider landscape, both urban and rural, it will be essential to create landscapes that are wildlife-friendly and permeable for species and to maintain ecosystem services. Sustainable land management principles should be applied to all activity. As part of this, Environmental Land Management will be important for ensuring wildlife opportunities, particularly for species that rely on the farmed environment.

6.1.4 Nature-Based Solutions

The Wildlife Trusts and other partners deliver a range of nature-based solutions to broader environmental problems. These include managing the risks of flooding (Natural Flood Management), utilising ecosystems to sequester atmospheric carbon (natural climate solutions) and mitigating water and air pollution to achieve nutrient neutrality or improve urban air quality. For each of these areas of work, the Nature Recovery Network can and should play a fundamental role in guiding where projects providing natural solutions should be located so that they achieve maximum added value for nature and, in particular, this may alter the design of schemes. For example, natural flood management often just uses woody dams but if there are clear opportunities for the NRN, then wetland creation should be used instead or in addition, enabled by funding support.

In some cases, different solutions will deliver multiple carbon benefits. For example, woodland creation for 'slowing the flow' and reducing flood impact may also provide carbon sequestration. However, there is a risk that separate funding streams on flood prevention and climate change do not properly consider what also makes ecological sense. Of course, nature should benefit whatever the driver and in such cases the Nature Recovery Network can direct where the most added value can occur.

In particular, healthy ecosystems have the potential to draw down vast amounts of carbon dioxide from the atmosphere through photosynthesis storing it as carbon. However, mapping a range of habitats in the UK found that 66% of carbon in nature-rich areas is outside protected sites[19]. We need to identify, map and protect these ecosystems and restore them locally as part of a national Nature Recovery Network.

Greenhouse gases such as carbon dioxide and methane are released naturally through processes such as the decay of plants and animals, exposure of soil carbon to the air, and wildfires. Natural processes also draw carbon dioxide from the air through the 'carbon cycle' (e.g. via photosynthesis). Habitats in good condition and well-functioning ecosystems store vast quantities of carbon as well as providing other important services such as clean water, flood mitigation and the production of food. However, human activity has both accelerated and increased the release of greenhouse gas emissions (e.g. through ploughing and peat extraction) and degraded nature's carbon storing abilities. In their degraded state, natural processes are disrupted, and ecosystems cannot achieve their full potential for locking away carbon and some, such as our damaged peatlands, currently release more carbon than they absorb.

Nature Recovery Network maps can be used to identify where farmers and other land managers should be incentivised to improve their land for nature and contribute to the network whilst also providing these public benefits. At sea, effective marine planning and an ecologically coherent network of Marine Protected Areas, which interacts with and supports the wider environment, will be fundamental to enabling marine ecosystems to recover and store the maximum amount of carbon.

Protecting existing woodlands and expanding tree cover will be vital for locking up carbon naturally and can have many added benefits, including greater access to nature in both rural and urban environments, air purification, temperature regulation, and increased biodiversity. However, other habitats can also offer similar multiple benefits and need to complement each other in order to deliver nature's recovery.

6.1.5 Catchment-Based Approach

River Catchment Plans are an example of locally and collaboratively developed plans which collate and prioritise freshwater conservation and water quality needs, often alongside other considerations such as flooding, fisheries, land management, and public access. They cover entire catchments and therefore, cumulatively provide full coverage of the English landscape.

For these reasons, they have many of the characteristics that a Nature Recovery Network will require – yet their focus on the water environment means that alone, they cannot inform the creation of a Nature Recovery Network. Developed by local stakeholders to reflect local priorities, they may focus on particular aspects of water-related delivery and may not reflect the full spectrum of issues across the water environment. Catchment Plans will often also be silent on aspects that have limited influence on the freshwater environment, being unlikely to have considered conservation priorities for chalk grassland or ancient woodland, for example.

However, the issue and opportunity mapping, stakeholder engagement and project prioritisation that has underpinned their production means that they can usefully help to inform the development of a Nature Recovery Network. As Nature Recovery Network mapping is likely to be carried out at a county or Unitary Authority scale, Geographical Information System (GIS) mapping enables catchment plans to be stitched together and cut to county boundaries. In ecological terms, this method could play an important role in providing a consistency of approach, and in helping to ensure ecological integrity across local authority administrative boundaries.

Catchment Plans are not static and as Nature Recovery Network mapping becomes available it should provide underpinning evidence for Catchment Plans, in an iterative process which will enable nature's recovery to improve the ecosystems on which society depends.

Where their aims are not already integrated within a Catchment Plan, the development of a Nature Recovery Network creates an opportunity to consider the potential for delivery under Flood Risk Management Plans, River Basin Management Plans, and Water Resources Management Plans (amongst others) through a single lens, as the priorities within each can all be overlain. Considering these alongside wider biodiversity opportunities identified by other plans or initiatives that inform the NRN may generate a range of actions that could be taken at a particular location, for example, an area of land could include woodland creation or scrape creation for natural flood management, or arable reversion to species-rich grassland to benefit pollinators. Understanding how the various contributing plans were developed will be informative in determining which of the potential activities will deliver the greatest contribution towards nature's recovery.

6.1.6 National Parks and Areas of Outstanding Natural Beauty

An independent review of National Parks and Areas of Outstanding Natural Beauty[20] recognised that these landscapes need to do more for nature and to enhance biodiversity. The Review included 27 proposals including that National Landscapes (National Parks and AONBs) should have a renewed mission to recover and enhance nature with strengthened Management Plans that set clear priorities and actions for nature recovery. The Review also proposed that "National Landscapes should form the backbone of Nature Recovery Networks – joining things up within and beyond their boundaries" (Proposal 4). In addition, in 2019, the 34 AONBs signed the Colchester Declaration[21] which sets out their collective ambition and intent to do more for nature including a pledge that each AONB should have a Nature Recovery Plan by July 2020.

Nature in our designated landscapes faces increasing pressures from visitor levels, climate change, agricultural change and damaging land management practices, development pressure and the spread of invasive non-native species, whilst the management bodies face ongoing resource constraints and sometimes conflicting statutory purposes (although the Sandford Principle for National Parks states that *"where irreconcilable conflicts exist between conservation and public enjoyment, then conservation interest should take priority"*[22]). Targeted action will make the best use of resources, ensuring that action for nature is carried out where it will be most effective. Nature Recovery Network mapping provides a robust evidence base for identifying where habitat enhancement, restoration and creation will help to make existing high value habitats in our protected landscapes richer in nature and more resilient.

In addition, National Park Authorities in England are listed as a Responsible Authority within the draft Environment Bill that can/should be involved in the preparation of Local Nature Recovery Strategies. This would require effective engagement and partnership work with County Councils and Unitary Authorities where there were overlapping areas of responsibility.

6.1.7 Health and Wellbeing

A Nature-disconnection Crisis
People's personal connection to nature has been declining for decades[23]. The abundance, quality and distribution of wildlife and wild places is reducing rapidly, and people's personal connection to nature has been declining as it becomes a less frequent and less significant part of our daily lives. At the same time, the need for wildlife and wild places in people's lives is increasing, to help us stay well and recover from illness — particularly when it comes to mental health and illnesses associated with obesity or loneliness. Despite the fundamental importance of nature to childhood the signs are that a generation of children is growing up at arm's-length from the natural world. Children's freedom to roam and time spent outdoors has shrunk, and with it their opportunities to discover wildlife[24].

Promoting greater access to nature

A natural approach to health and wellbeing is an evidence-based and cost-effective way of contributing to preventative healthcare. It should be playing a more significant role in the prevention and treatment of illnesses. People's health and wellbeing can be improved by ensuring there are easily accessible wildlife-rich natural spaces where they live and work. This is particularly important where access to nature is poorest, and pressure on health services is greatest. Here then, inequality in access to nature becomes an environmental and social justice issue, with obvious political resonance. Evidence of opportunities for nature enhancement (in Nature Recovery Network Maps) should be combined with spatial data on health inequalities and access to natural greenspace, enabling Local Nature Recovery Strategies to identify where access to nature is poor and set out action to improve it. The strategies can help prevent health problems at scale by showing where new housing can be situated within easy reach of wild green and blue spaces and where significant areas of nature-rich space needs to be incorporated into new development. This would make daily access to nature easier for all, to improve the mental and physical wellbeing of those who live there, helping to reduce the burden on the NHS. Progress in contributing to the Nature Recovery Network in this way could be used as a measure of success for Public Health policy delivery.

Some nature can flourish alongside human use of a site, but other species are sensitive to disturbance and other impacts that sharing space with people can bring. A balance needs to be achieved to provide people with access to nature without compromising nature's ability to recover. Singapore's system of networks could be a good model — where many parks and corridors are both for nature and people, while some are just for nature. This also benefits people as it increases net biodiversity in an area — something which wouldn't be possible if all these spaces were for both people and nature.

DIANA FARINA

6.1.8 Green Infrastructure Strategies

Many Local or Combined Authorities have developed, or are developing, Green Infrastructure Strategies, which facilitate a strategic and coordinated approach to green infrastructure within the area covered by the strategy. Green Infrastructure Strategies should also inform the development of Local Plans or Spatial Strategies.

All too often 'green' infrastructure is more about tarmac than wildlife and the needs of biodiversity may sit a long way down the priority list below access, recreation, Sustainable Drainage Systems and sustainable transport. Embedding the Nature Recovery Network into green infrastructure development will ensure that key wildlife corridors and sites are maintained/created, that their location considers wildlife connectivity as well as where is useful for people, and also will help separate out where it is appropriate to combine wildlife corridors with other uses, e.g. access, and where it is not.

It is therefore important that Nature Recovery Networks, which provide a spatial vision for coherent and resilient ecological networks, underpin the development of Green Infrastructure Strategies:

- the Nature Recovery Network should form a key part of the evidence base for development of green infrastructure, facilitating the delivery of green infrastructure and the avoidance of development that is detrimental to nature within the Nature Recovery Network;
- the approach to green infrastructure contained within Green Infrastructure Strategies should seek to actively contribute to the Nature Recovery Network.
- green Infrastructure Strategies should make recommendations for how Local Plans and other Strategies can be used to develop the Nature Recovery Network and identify specific actions for development of the Nature Recovery Network.
- strategic green infrastructure projects identified through Green Infrastructure Strategies should contribute to the Nature Recovery Network and improved access for those communities subject to the greatest barriers to free engagement with nature, so that by 2030, everyone is better connected with the natural environment.

The interface between any Green Infrastructure Strategy and other spatial strategies that are not specifically focused on enhancement of the natural environment is especially important in ensuring that the Nature Recovery Network is explicitly considered within these strategies. A strong Green Infrastructure Strategy that properly integrates the Nature Recovery Network should help to ensure that regional or local spatial planning makes a positive contribution to the Nature Recovery Network.

Gloucestershire Wildlife Trust has developed the Building With Nature[25] standard, an accreditation scheme which assesses development proposals over three themes: wildlife, wellbeing and water. The scheme is designed to enable developers who want to go beyond the statutory requirements to create places that really deliver for people and wildlife. The scheme provides a scale of accreditation, but all development plans must demonstrate a contribution to a network for nature in order to meet the accreditation criteria.

West of England Joint Green Infrastructure Strategy
Case Study

The West of England is developing a Joint Green Infrastructure Strategy, which is owned by the West of England Combined Authority and the four Local Authorities within the West of England region. The strategy sits alongside and helps facilitate the delivery of other regional and local plans and strategies. It aims to:

- provide key concepts and tools to enable a consistent approach to green infrastructure across the West of England;
- promote the development and use of a shared green infrastructure evidence base for Local Plan development and other joint or local plans and strategies, and the development of projects/business cases, to contribute to green infrastructure enhancement;
- set out the role and the current extent of the existing green infrastructure network, and identify both issues and new opportunities for enhancement;
- recognise the need to prioritise the planning, development of investment in, and monitoring of green infrastructure as part of the response to the climate and ecological emergencies, and to new duties including Biodiversity Net Gain and the delivery of Local Nature Recovery Strategies;t
- highlight the means by which organisations, communities and partnerships can work collectively to create and sustain a fit for purpose green infrastructure network across the West of England;
- provide a prospectus for partners to develop projects to enhance and extend the green infrastructure network.

The spatial mapping of a Nature Recovery Network for the West of England has underpinned the development of the Strategy, and the Joint Green Infrastructure Strategy Action Plan includes the following action: 'West of England Nature Recovery Network is to be used by West of England Combined Authority and the four Unitary Authorities to assess, identify and prioritise opportunities for ecological enhancement through their Local Plans and strategies including any Local Nature Recovery Strategies (Environment Bill) and delivery of Biodiversity Net Gain'.

Hackney Green Infrastructure Strategy
Case Study

Hackney Council, an inner London borough with an imbalanced distribution of greenspace, has embarked on a four-strand approach, with strong member support, to:

- Review and update of Sites of Importance for Nature Conservation (Local Wildlife Sites) to inform Local Plan (LP33), Local Nature Recovery Strategies, Green Infrastructure Strategy and Parks Development Plan
- Review of 2012-19 Biodiversity Action Plan to become a Local Nature Recovery Strategy, informed by the SINC review, setting out a NRN to inform the Green Infrastructure Strategy, Parks Development Strategy and Local Plan
- Develop an overarching Local Nature Recovery Strategies, from review of evidence base, mapping, etc aligned with regional and national policies, informed by Local Nature Recovery Strategies, and other internal drivers (e.g. tree strategy}
- Prepare a Parks Development Plan to set out how Council owned-green assets will be managed to meet objectives of GIS, Local Nature Recovery Strategies and other strategies.
- All above will involve stakeholder engagement to inform priorities for future action.

PAUL HARRIS

6.1.9 Local Natural Capital Plans

Living things underpin all ecosystem services. Conceptually, natural capital represents an attempt to sum the economic value of all the ecosystem services provided by the entire biosphere. In these terms, natural capital then becomes a 'stock' or asset, and ecosystem services are the flows from that asset that result in the consumable products, more or less essential to our existence. Natural capital mapping starts with the basic habitat data of the Nature Recovery Network. Then ecosystem services and integrated environmental data are overlaid with conventional economic valuation metrics, to reveal a minimum natural capital value — as some ecosystem services are just too abstract to monetise — of a typically administrative area of interest. This shows how land use interventions could increase

or decrease the value, thus enabling the impact of investment decisions and development to be better understood. This provides a method to mitigate any serious depletion or loss of natural capital. It can also highlight opportunities for investment in natural capital to deliver multiple benefits for the economy, society and wildlife.

Multiple benefits can be delivered by single interventions. Natural capital thinking allows for all these benefits to be considered alongside one another recognising that biodiversity underpins other benefits. This will be useful for land managers, planners and those interested in promoting sustainable growth. The multi-benefits approach encourages cost efficiencies, reveals the best opportunities for co-locational planning and enables the broadest range of funders to become involved in delivery of environmental benefits.

6.2 Where the resources might come from

Conventional methods of funding delivery of environmental benefits have thus far been insufficient to halt the decline of biodiversity and take advantage of natural solutions to the challenges our society faces — local authorities, farmers and nature conservation organisations alone cannot solve this problem. Nature's recovery relies upon coordinated action from all stakeholder groups of society. Innovative financial models and 'green' investment mechanisms can secure finance from a multitude of stakeholders to deliver environmental benefits if properly designed, implemented and communicated to provide clear and tangible benefits. The concept of natural capital facilitates such financial models and mechanisms, as it allows for the consideration of a multi-benefit approach — investment in, for instance carbon sequestration or natural flood management can also deliver benefits for nature recovery.

There are many potential funders (and drivers):
- Local authorities (carbon neutral agenda).
- Developers (biodiversity net gain).
- Local Enterprise Partnerships: Both the BEIS Clean Growth Strategy and Industrial Strategy recognise natural capital as a driver for economic growth and the potential Shared Prosperity Fund could be an investment source, especially where the environment has been included in the Local Industrial Strategy. Spatial planning for nature's recovery provides a strong evidence base for strategic decision making that will support a sustainable and low carbon approach to economic recovery.
- Water companies and other infrastructure operators (e.g. through Payment for Ecosystem Services such as improved water quality and through national biodiversity targets in their Outcome Delivery Incentives).
- Corporations (carbon neutral agenda, natural capital investing, Corporate Social Responsibility).
- Environmental Land Management Scheme.

Better regulation and enforcement, community and individual action and rewilding approaches can also enable delivery of the Nature Recovery network with lower levels of investment.

Regulation can lead to land being released to become part of the Nature Recovery Network. In some instances, when regulations are enforced, land uses that currently appear viable may not be once fines are taken into account.

Community initiatives and individual action may require little direct funding but instead may require some coordination. This type of action is likely to be made up of many small interventions which add up to a lot across a landscape.

Rewilding is a large-scale method of restoration at a relatively low-cost. Large estates, networks of landowners and some companies may consider this as a viable option to achieve a range of objectives.

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Appendix 1:
Connectivity and opportunity mapping methodology

Section 3.3 of the NRN Handbook sets out the process for developing local Nature Recovery Network maps with the aim of facilitating a consistent approach across the country whilst providing sufficient flexibility to reflect local circumstances. Mapping and modelling current ecological connectivity and opportunities for where this can be improved provides the evidence that can be used to identify the nature recovery zone. This appendix sets out a methodology for mapping ecological connectivity and refers to some other tools and approaches that can be used to inform the Nature Recovery Network map.

We recommend that the connectivity and opportunity mapping for the Nature Recovery Network is based on UK Habitats Classification (UKHab). UKHab uses a combination of primary and secondary codes to classify habitats. In some cases the primary code will be sufficient but the secondary codes add clarification, particularly with habitat mosaics. For example, traditional orchard and wood, pasture and parkland only exist as a secondary code. For these habitats, the ground cover is the primary code and then the secondary code provides further detail that it is, e.g. an orchard. It is possible, using a combination of primary habitat and secondary codes to allow for habitat mosaics, habitat management and other environmental features to be added to each coded primary habitat. It is also possible to include information on the condition of a habitat by using the secondary codes relating to management as a proxy. If everyone is using a similar, high resolution baseline, then the results should be comparable even with different models. It provides a robust and repeatable habitat classification system which is important for baseline surveys and monitoring.

Step 1: Create the base layer cover map

As a minimum, a complete land use cover habitat map is required and should consist of UKHab[25] Level 3 data for the whole area. Level 3 classifies habitats to one of the 20 UK Broad Habitat types. Where possible and the data permits, further classification to Section 41 priority habitat (Level 4) should be done. Ideally there should also be an overlap into adjacent areas of at least 3km (but this figure may require further testing[26]). This will allow the assessment of connectivity to habitat patches and the identification of nearby opportunities that may just be within another administrative area but still sufficiently close

from an ecological perspective to be considered part of the network. However, there will be data copyright and ownership issues to overcome when requesting data from another administrative area(s), including Ordnance Survey, the public body under whose Public Sector Mapping Agreement (PSMA) licence that the data was mapped to (such as a County Council) and any other shared Intellectual Property Rights (for more information on data licensing, see Appendix 2).

There are a number of ways to get the data (e.g. Phase 1, Priority Habitat Inventory, CEH Land cover map, satellite imagery, survey data and information from designated site citations) but it should all then be translated and classified using UKHab as a standard way to create a uniform dataset. It is also worth noting that, as of 10 July 2020, the UK Centre for Ecology and Hydrology (CEH) Land Cover data for 2019 (and 2017 and 2018) is now available free for all non-commercial use[27].

It may also be possible to assign a quality and reliability score to the various data sources used and then assign a hierarchy so that if a land parcel has data from a number of sources, the 'best' is selected. The habitat base layer does not need to differentiate between habitat within or outside of designations. A layer of protected sites will be important for identification of the Nature Recovery Network core zone but is less useful for connectivity modelling, which is simply based on ecological data. However, site designations and their associated records can be used to assign quality and reliability scores to habitats found within them.

The connectivity and opportunity mapping methodologies to inform the Nature Recovery Network require habitat data. The mapping and various computer models used require input data in a consistent, useable format (e.g. habitat inventory). If the maps identified existing protected or designated areas as whole units, rather than as their constituent habitats, critical information on network priorities for different habitats would be lost. Appendix 2 suggests how the data from protected sites can be used to inform the habitat/land cover map including for ground-truthing remotely sensed habitat data. Of course, protected sites are fundamental to the delivery of the Nature Recovery Network (as the core zone) and for consideration within Local Nature Recovery Strategies (see Section 4).

Step 2: Group main habitats

Once a complete cover habitat map is available, the next step is to group the main habitats. We suggest using the eight broad categories identified within the UK National Ecosystem Assessment[28] with **woodland, grassland and wetlands being fundamental**. However, it may be that flexibility is required for local circumstances and local iterations. For example, in Gloucestershire, traditional orchards are considered as a separate network from the woodland network because they are a particularly significant habitat for the county. In other counties, where they may be less numerous, they may just be included as a permeable habitat within the woodland grouping.

In terms of wetlands, whilst rivers and ponds appear on the habitat layer, it is suggested that they be removed from the wetland network and/or treated as a separate layer along with hydrological maps for mapping opportunities and constraints. The reason being is that in many places, ponds are tiny, numerous and scattered across the mapped area. This makes them difficult for the models to deal with. Where available, it may be possible to use the great crested newt mapping layer. The inclusion of rivers is about structural connectivity but when considering a wetland network, it is more important to understand functional connectivity and that is largely related to soil and topography. A river layer does provide a useful visual feature to overlay the outputs.

It may also be desirable to consider including linear features such as hedgerows as an additional category or as an after-model overlay.

There are some habitats, such as heathland, that vary in extent across the country. How this habitat is grouped will need to be decided locally. For example, if there is very little heathland, then it could be grouped with open habitat. If the area has a significant number of habitat patches and/or large contiguous layers, it might be more appropriate to map as a separate network. It is advisable to start with as much detail as possible and then aggregate afterwards if required.

Step 3: Understanding current connectivity

Mapping the existing connectivity between core habitat patches within each of the grouped habitat networks enables the answering of questions about the current state of the network. For example, we may want to ask whether an activity will sever a core network.

GIS tools such as cost distance analysis can model the current state of functional connectivity, showing which habitat patches are joined together as a functionally connected network of patches within the model. This type of analysis considers existing land-uses and assigns each land-use a theoretical permeability score[29]. This results in the modelled cost distances (equivalent to dispersal distances), and hence the modelled habitat networks themselves, being lessened where there are intensive land-uses. Extracting the data for different maximum cost distances (dispersal distances) from the model output can indicate the differing extents of connectivity depending on the dispersal ability of a species. This model may mean that intensive land uses (e.g. arable areas) are considered to be largely impermeable (with a 'high' cost for species to disperse and, therefore, low permeability scores) and of low priority within the network. However, this analysis is just based on their current ecological contribution to the network and these areas may actually offer significant opportunities for really large-scale habitat creation and/or restoration (see Section 5).

Ideally, there should also then be a consideration of habitat patch and network coherence and resilience. This is also only an assessment of how resilient and coherent the current network is but that could be used as a basis for considering opportunities areas. The Natural England Living Maps: Satellite-based Habitat Classification[30] appendices include some suggested viable network and core habitat areas for select habitats. It should be possible to use the minimum viable core habitat area and the minimum viable network area as thresholds for resilience.

By re-running the connectivity modelling and varying the parameters (i.e. determine the parameters for more than one species and then run the analysis for each), it can also help to make decisions about where the greatest number of species could benefit from habitat restoration and creation. However, in areas with very little core habitat area, further analysis is required.

Step 4: Identify opportunity areas
(better and bigger elements)

The connectivity modelling (above) provides an assessment of current connectivity based on the existing habitat network and known ecological parameters. To identify new areas of opportunity away from existing areas requires further analysis. It needs to consider the constraints and opportunities to prioritise for better and bigger elements of restoration. To do this, the cost distance analysis model works outwards from the existing core habitat connectivity using increments which are relevant to that network (for example, 500m, 1km to 5km for grassland) by incorporating the cost distance output with weightings which go from high at 500m to low at 5km. To address constraints, it also excludes particular habitats from the network that would be inappropriate (e.g. conifer PAWS are excluded from the open habitat network because they are a priority for woodland restoration and would be inappropriate for an open habitat network). This process is about making existing core habitat areas better and bigger and the existing networks more robust.

A number of different data layers can be used but suggestions include:

Opportunities	Constraints
Ecological network connectivity increments	Habitat suitability (priority habitat or other)
Agricultural land grades	Landscape character
Low input permanent pasture	Heritage sites (for woodland network)
Soil type/topography/hydrology	Soil type/topography/hydrology
Ownership	
Heritage sites (for open habitat network)	

Combining the network maps for the grouped habitats
Opportunity mapping will always result in priorities for more than one network occurring in the same location. However, simply overlaying the maps for the different networks is not easy to interpret and can be confusing. Combining the ecological network layers within GIS and displaying them as a single layer can aid interpretation but needs to be presented in ways which can help inform decision making about which habitat to prioritise in which location. However, the final decision will need to be based on expert interpretation of the information and/or stakeholder engagement.

To combine the woodland and open networks, conditional statements are used in the raster calculator tool to decide which takes priority in a particular location. The thresholds for these decisions are set using the opportunity map scoring, being divided into high (top 20% cover), medium (next 10%) and low (the rest) categories. The conditional statements then compare the rasterised opportunity layers and assign each cell in the raster to one of 10 categories[31].

Alternative methodology for opportunity mapping[32]

This approach also requires main habitats to be mapped (ideally Section 41 priority habitats or Level 4 in the UKHab classification) and then grouped into broad habitat types. Through modelling, this map is then used both to understand where existing ecological networks are located and how they fit together and also to identify opportunities for habitat creation, restoration and connectivity. Unlike the previous methodology, the model is based on geometric proximity principles and doesn't consider how the underlying land use affects species movement and dispersal between habitat patches.

The model used is based on an inverse distance-weighted algorithm. Each habitat is given a weighting appropriate to its qualitative ecological contribution to its broad habitat group (e.g. semi-improved neutral grassland would be given a lower weighting than unimproved neutral grassland). As with Step 3, the model favours areas near to or between existing habitat patches and, it also recognises that larger habitat patches are of greater ecological value than smaller

ones. However, the model works in a slightly different way. Each polygon (50mx50m) is assigned a score that is calculated according to proximity, quality, number and size of patches of a given habitat within a search area. The highest scores would be assigned where a square was located closely between several existing habitat patches or adjacent to very large patches. The highest scoring areas indicate where habitat restoration would likely be of the greatest potential benefit to improving the ecological network for a given core habitat type. Scores are relative and on a continuous scale with higher values indicating areas where there is theoretically a better chance of improving an ecological network than lower value areas.

In this method, each habitat network is modelled separately but interpreting them as individual outputs is difficult especially where there might be areas of overlap. However, further analysis can be done within GIS to combine them into a single layer. This is also accompanied by tabular information that identifies the habitat(s) present and/or to be restored and created for each given location.

Unlike the previous model (Step 4), this methodology does not consider constraints. The Inverse Distance Weighting modelling fills in the gaps without worrying about the underlying land use. This means that the output covers the whole of the area under consideration (e.g. county) with high, medium and low opportunities for habitat restoration and creation. Further interpretation is needed to prioritise these.

Step 5: Connections across the wider network
(more and joined)

Both models help to identify the opportunity areas with the greatest potential to enhance existing connectivity and/or to expand existing networks. They can also highlight, visually, where there are gaps or areas of poor habitat/network resilience in the network. This is valuable but further work and analysis is required in order to be able to identify where to prioritise new habitat beyond existing networks.

The connectivity model largely excludes arable and other intensive land uses from potential network expansion priorities as they are considered to be impermeable (with low permeability scores) within the connectivity modelling. Similarly, the Inverse Distance Weighted model assigns a low priority to areas with no

nearby priority habitat, which is likely to mean that intensively farmed areas score low. However, arable areas may offer better opportunities for really large-scale habitat creation than might be found within the core network, and these would deliver huge gains for nature. Such schemes are vital to connect existing networks and enable nature to adapt to climate change.

Identifying opportunity areas within the gaps in the network or in areas that are currently of low biodiversity value or with a high concentration of seemingly impermeable habitat either requires expert interpretation and/or stakeholder engagement or to adopt a different modelling approach. The ideal way to approach this is to look at the modelling outputs and identify the gaps and how isolated various core habitat/network areas are located and then consider opportunity areas and how these can be connected into the network.

It will need the involvement of local stakeholders to build networks across areas that are currently poor for wildlife. It might be that Local Nature Recovery Partnerships can use the habitat and connectivity mapping to identify opportunity areas and decide where to focus effort. In addition, at this stage in the process, there is also an opportunity to use modelling such as Condatis[33] (a decision support tool to identify the best locations for habitat creation and restoration to enhance existing habitat networks and increase connectivity) in conjunction with stakeholder engagement.

Identifying areas of focus or places to enhance connectivity will need to be an iterative process that is refreshed and evolved as new data and/or opportunities materialise. It will also need to tie in with other policy and delivery mechanisms. For example, when identifying areas for woodland creation as part of nature-based solutions, it will be important that the location of newly created areas are informed by the local Nature Recovery maps and then they become part of the network and/or are used to connect up other areas in due course. The 'gaps' in the network may present the greatest opportunities for large-scale restoration and nature's recovery. This stage also provides an opportunity to consider how the network will best provide connectivity to address the challenges of dispersal as a result of climate change.

Step 6: Sharing the end product

And interpretation of the maps

To be of influence, the local Nature Recovery Network map(s) need to be viewable and stored and shared in a way that enables the partnerships access to and use of the same map. However, it may be that different levels of access are provided for different users. For example, a high-level version for the public but finer scale and with more detail for Local Authorities perhaps with the ability to switch layers on and off. Another route may be for paid access with the money generated being used, for example, to update the habitat mapping. This is a similar model to developers currently paying for access to data.

The output is also unlikely to be a single map that will tell you everything. It will be essential to provide guidance on how to interpret the maps with bespoke information for a range of different audiences (e.g. developers, Local Planning Authorities, those developing Environmental Land Management Schemes).

Step 7: Updating the maps and monitoring

Network maps should be made to be easily reviewed and should be updated as a result of monitoring outcomes and as better evidence emerges (see Section 5 for detail on monitoring and evaluation).

The graphical modelling tools in GIS packages (e.g. Graphical modeller in QGIS and Model builder in ARCGIS) now enable the steps of the mapping process to be saved as tools which can be quickly re-run enabling the maps to be easily updated on a regular basis. A lead body or role should be identified for this to avoid confusion and provide a system of 'ownership' of the process (including a repository for the data and mapping layers).

Open access toolkits could also be made available for QGIS in Graphical modeller or ARCGIS in Model builder to enable monitoring of progress towards delivering the Nature Recovery Network through changes in land use.

Appendix 2:
Data Considerations

Habitat-based data

Habitats are the raw ingredients in Nature Recovery Network mapping. The greatest barrier to achieving locally developed but nationally consistent Nature Recovery Network mapping is the variable resolution and quality of data sets being used for them across the country.

A habitat inventory is a map of all existing patches of habitat in an area. GIS programmes can convert vector data (lines and polygons) to Raster data (grid squares of any defined resolution) and vice versa. Inventories are best mapped and kept as vector data because this is the most accurate approach and ensures no overlaps or missed features. However, depending on the Nature Recovery Network modelling approach used, this may need to be converted to Raster format. Unless a very high resolution is used there will be some loss of data in this process. The accuracy and reliability of Raster-format data is heavily dependent on resolution chosen. Higher resolution will result in the highest accuracy but there is a trade-off in the terms of the computing time required to run the Nature Recovery Network models.

When creating a habitat inventory a minimum mappable unit size is normally chosen. Any habitat patches below this size will not be included. There is a trade-off between digitisation time and dataset quality. Within reason, the smaller the minimum mappable unit the better because this will produce the most accurate and comprehensive dataset. The UK Habitat Classification System (UKHab) — which we recommend for use as part of the connectivity and opportunity mapping for a Nature Recovery Network (see Appendix 1) — recommends $25m^2$ for landscape-scale mapping and $5m^2$ for site-based mapping. The Rural Payments Agency already map landcover at the parcel level as part of the various Countryside Stewardship schemes. For Nature Recovery Network mapping, we recommend mapping to $10m^2$ where possible (with a recognition that in areas where habitats are highly fragmented this may need to be adapted).

Each Nature Recovery Network computer model relies on habitat data existing in a consistent and specific classification system. The two most commonly used habitat classification systems are Phase 1 and the more recent UK Habitats Classification. It is broadly possible to convert a dataset from one system to the other but UK Habitats Classification is more precise and detailed

than Phase 1 so there are some difficulties with doing this. However, UK Habitat Classification is a nested hierarchy so a broad habitat may be identified even if a high level of detail cannot. UK Habitat Classification has been adopted by Natural England and is used in the biodiversity net gain metric calculator.

Protected sites and other site-based data

Protected sites and other site-based data, such as Local Wildlife Sites, Sites of Special Scientific Interest, nature reserves and ancient woodlands are not the input data for the habitat/land cover map *per se* but in some cases the information may be able to be transformed into input data or used to inform the input data, particularly as these are the sites where the best ecological knowledge is likely to exist for many counties. For input into computer models, site-based data in themselves are not compatible with area-based data, such as found in a habitat inventory. This is because all coherent computer-based Nature Recovery Network modelling approaches need to use a consistent format of input data. They also need to identify the location of different habitat types in order to look at how similar habitats are currently connected and then identify the potential opportunities to enhance connectivity. Habitat-based data are essential for a computer model to be able to inform habitat creation choices. Site-based data cannot do any of these things without prior transformation and separation into discrete areas of different habitats.

Transforming Local Wildlife Sites and other sited-based data: in areas where a reliable and comprehensive habitat inventory does not exist, it may be possible to transform site-based information into habitat-based data. Comparing site citations with site survey maps or publicly available aerial photography, habitats within a site can be digitised. However, this should be a last resort. Without a more comprehensive approach to gathering habitat-based data, there will be significant errors and omissions in the input data. If possible, it is far better to instead use site-based data to inform a more comprehensive habitat inventory. The UK Centre for Ecology and Hydrology has now made their 2019 Land Cover data freely available for all non-commercial use[34] which should mean greater NGO-access to a high-quality national dataset of land cover (albeit in a raster format and to $20m^2$ resolution).

Informing input data using Local Wildlife Sites and other site-based data: where a habitat inventory already exists or where a new one is being produced, site-based information from field surveys can be used to check the accuracy of, and refine, remotely-sensed habitat data and inform a more comprehensive habitat inventory. Site-based information can also be very useful for helping to assign quality scores to existing habitats.

Soils and constraints

It is well understood that a number of general habitats are physically constrained and can only exist on specific soils or other physical conditions, such as hydrology. For example, chalk grassland can only occur on surface chalk soils. In order to understand priorities and inform habitat choices, relevant physical/geographical constraints need to be mapped and the outputs constrained as appropriate and relevant.

On the other hand, intensive land-uses, such as urban areas or arable fields, should not be viewed as constraints to the Nature Recovery Network. It is important for these areas not to be excluded for several reasons and indeed they should be considered as important opportunity areas for habitat creation and/or enhancing connectivity. Existing land that is currently of little biodiversity value, such as arable areas, can often be a major opportunity for creating new habitats and there are plenty of case studies of arable conversion to new habitat. Therefore, if intensively managed land such as arable were to be excluded, opportunities for the Nature Recovery Network will be overlooked. Urban areas also provide opportunities to contribute to the Nature Recovery Network. Wildlife-rich green spaces already form wildlife corridors and stepping stones through our towns and cities. Parks and areas of amenity greenspaces can be enhanced through more wildlife-friendly management and road verges, private gardens, living roofs, and other urban greening initiatives can all play their part. The practical solutions to a Nature Recovery Network in urban areas may often differ in scale and approach from those elsewhere but must not be underestimated.

Data licensing and open data issues

Licensing of habitat data is often not straightforward. In most cases when data are surveyed and digitised, they are georeferenced from an Ordnance Survey map background. This inevitably results in habitat data being derived from Ordnance Survey data and is therefore subject to the same intellectual property rights and licensing restrictions as the Ordnance Survey dataset itself. In practice there could be restrictions in force from up to three different parties: Ordnance Survey directly; the public sector body under whose Ordnance Survey licence the data were derived, often a county council; and the owner of the survey data. This applies to any habitat data inputs to Nature Recovery Network computer models, as well as potentially the outputs if these fulfil the criteria of being derived data.

It is important to understand any restrictions in place and permissions needed before copyright data are published in any way, made open or otherwise shared between parties. In practice making these types of data fully open is problematic. Moreover, many such datasets across the country are maintained and supported by Local Environmental Record Centres. It is critical that the business models of these record centres are not inadvertently undermined by an ambition to make these types of data open because without record centres the continued flow and maintenance of data into the future would be compromised.

Whilst an unfunded aspiration of fully open data would likely be damaging to record centre business models, it is recognised that a Nature Recovery Network map needs to be available to be used by stakeholders and end users if it is to practically fulfil its purpose. This could be solved by long-term funding committed to Local Environmental Record Centres. Otherwise, a compromise may be possible whereby different levels of access are provided for different users. For example, a high-level version for the public but finer scale for Local Authorities, perhaps with the ability to switch layers on and off. It could be that the Nature Recovery Network maps are only publicly available at a coarse resolution and level of detail. This is a principle that appears to work and be accepted for Ordnance Survey data. For example, small scale Ordnance Survey maps are open, whereas their larger scale maps (at the more detailed resolution) are not. This principle would allow open access Nature Recovery Network maps to inform strategic decision making but more detailed localised projects would need to approach the relevant Local Environmental Record Centre to obtain the necessary level of detail. Another route may be for paid access, with the money generated being used, for example, to update the

habitat mapping. This would be the most similar to the existing business model of record centres where, for example, developers pay for access to data. There are potential solutions but they need to be discussed and agreed with the data owners.

Best available data

Nature Recovery Network maps must be based on the best available habitat data for an area and maps should be updated as more data becomes available. For example, Land cover maps will need to be updated (e.g. by Local Authorities reporting back on habitat created as a result of biodiversity net gain) and the connectivity models could be re-run with the addition of this new data to compare to previous iterations.

Considerable public funds and volunteer time have been spent to achieve various habitat survey data across the country and it is essential that these are put to best use. The level of data, accuracy and how up to date it is varies in different parts of the country and currently there is no single national combined dataset that uses all the best available data. Natural England's existing national habitat inventory varies greatly in its quality and accuracy and has not been updated with the majority of available survey data. In some parts of the country it is more than 70% incorrect and therefore its use should be disregarded for parts of the country where better data exist unless it is able to be updated to incorporate best available data. Natural England is also working on its Living Maps project that generates habitat data from remote sensing. However, remote sensing is not able to accurately classify all habitats and assess their quality. To be a reasonably accurate dataset it relies on substantial ground-truthing. Again, if it were to use all best available survey data, with confidence values assigned to the data, to refine its results, it would have potential to be a suitable dataset.

However, it is really important that when mapping the Nature Recovery Network, we do not support a lowest common denominator approach for data and only use datasets that are available and/or consistent across the whole area. Instead, we must use the best quality data at any given location (see above re. data on protected sites) and, if required, provide a confidence value in that data that is very clear to the end-user. This can then be updated as more data becomes available and/or identify where better data is required through data collection and/or monitoring.

Appendix 3:
Why 30%?

1. Context

The UK has a human dominated landscape with a large degree of habitat loss and fragmented natural ecosystems. In areas where there is little semi-natural habitat left, research shows that ecological sustainability can be achieved through the creation of ecological networks[35].

The principle is well established and was politically accepted in the 2011 Natural Environment White Paper[36]. This was informed by the Lawton review[37], which was set up to look at our wildlife sites and whether they are capable of responding and adapting to the growing challenges of climate change and other demands on our land. The Lawton review said no, England's collection of wildlife sites is generally too small and too isolated to provide a healthy natural environment; we need more space for nature. It concluded that in order to create a coherent and resilient ecological network, we need more, bigger, better and joined space for nature.

Many Wildlife Trusts have thought about what this might look like and have mapped ecological networks — mostly on land, but some also at sea. This thinking has now developed into a call for a national Nature Recovery Network in England and similar networks for nature's recovery in the devolved administrations. We believe that the area where active recovery for nature is happening should cover at least 30% of land and sea.

2. Why 30%?

Some researchers have suggested that this is the coverage of semi-natural habitat required to provide ecological connectivity within an area.

The 30% threshold of habitat cover in a landscape has been determined as the point at which the spatial distribution and area of that habitat is generally sufficient to provide connectivity for a range of species populations[38, 39, 40]. At less than 30% cover habitat patches become small and isolated and species richness, abundance and survival declines[29, 41, 42, 43]. Where habitat cover is greater than 30% habitat patches will be larger and the distance between patches will be less resulting in greater connectivity[29, 30, 31].

Of course, thresholds are likely to differ between landscape types and for different species[44]. The 30% threshold has been supported for woodlands and grasslands[45, 30, 31] which make up much of the lowland habitat matrix of the UK.

At **sea**, habitat connectivity works differently, but 30% minimum for nature's recovery also works for marine habitats. The guidance on creation of an Ecological Network of Marine Conservation Zones (MCZs) considered that a marine network needs between 10% and 40% of a list of broad-scale habitats to be protected and managed so a wide range of wildlife can survive and thrive.

There is a challenge to applying minimum habitat thresholds as conservation targets. Like anything in nature, there are no absolutes, different circumstances require different approaches. Some researchers are concerned about "oversimplification and generalization of the concept"[46] but this is most relevant to area management strategies. It could be argued that to agree a goal across the whole of the UK we need to keep it simple and apply general principles.

There is a discrepancy between saying that we want 30% coverage of semi-natural habitat in each county and that we want an ecological network that covers 30% of each county — the former suggest a more evenly spread approach but this is neither necessary nor desirable if we follow Lawton principles.

3. Why does this have to be achieved by 2030?

Positive, focused action, will lead to a sustained period of recovery through the right choices, planning and investment. We need to act now to give nature the best chance of recovery. Our campaign takes its lead from the UN Convention on Biological Diversity (CBD). This is an agreement between countries based on natural and biological resources, with 3 main goals: to protect biodiversity; to use biodiversity without destroying it; and, to share any benefits from genetic diversity equally.

Governments were due to adopt a new set of biodiversity targets during talks in Kunming, China, in October to replace the 2020 goals agreed in Aichi, Japan, in 2010. Most of these have been missed. A major report in May 2019 by the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) warned species extinction was accelerating with ecosystems deteriorating at rates unprecedented in human history.

The CBD's draft text will form the basis for negotiations, and is to be discussed at the fifteenth meeting of the conference of parties to the CBD — called COP15. This has been postponed due to the Covid-19 pandemic. In preparation for COP15, a CBD working group has drafted a post-2020 global biodiversity framework.

Goal 1 of the framework is "No net loss by 2030 in the area and integrity of freshwater, marine and terrestrial ecosystems, and increases of at least [20%] by 2050. They have also proposed two targets relevant to our rationale on 30% of land and sea for nature's recovery:

A.   Retain and restore freshwater, marine and terrestrial ecosystems, increasing by at least [50%] the land and sea area under comprehensive spatial planning addressing land/sea use change, achieving by 2030 a net increase in area, connectivity and integrity and retaining existing intact areas and wilderness.
B.   Protect sites of particular importance for biodiversity through protected areas and other effective area-based conservation measures, by 2030 covering at least [60%] of such sites and at least [30%] of land and sea areas with at least [10%] under strict protection.

The EU Biodiversity Strategy (published in May 2020) aims to put Europe's biodiversity on the path to recovery by 2030 with commitments to establishing protected areas for at least 30% of land and 30% of sea in Europe along with agreeing legally binding nature restoration targets in 2021.

4. How does this connect to global marine conservation targets?

4.1 Global Ocean Alliance 30by30 initiative

Our campaign takes a lead from and aims to help progress this Global Ocean Alliance **30by30** initiative, which focuses on our oceans and is pushing for at least 30% of the global ocean to be protected in Marine Protected Areas by 2030.

In September 2019 the UK announced a new global alliance to help drive urgent action to safeguard the world's ocean and protect its precious wildlife. This has so far been supported by 13 countries.

Less than 10% of the world's ocean is currently designated as Marine Protected Areas. These protections help sensitive species such as seahorses, turtles and corals to thrive, and can help fight climate change by protecting key carbon habitats such as mangrove forests and seagrass meadows. Science shows such areas are one of the most important ways to protect precious sea life and habitats from damaging activities — and evidence supports a target of at least 30% to reverse existing adverse impacts, preserve fish populations, increase resilience to climate change, and sustain long-term ocean health.

The Alliance was planning to call for the 30by30 ambition to be adopted at the 2020 Convention on Biological Diversity conference in China, however this was cancelled in March due to the Covid19 pandemic. The Alliance also intends to have the target introduced into international law through the High Seas Treaty in 2020.

4.2 The Blue Belt – Marine Conservation Zones

The 30by30 campaign builds on the UK's world-leading efforts to increase Blue Belt protections. The UK government designated 41 new Marine Conservation Zones in May 2019, marking the most significant expansion of England's 'Blue Belt' to date. The UK now has a total of 355 marine protected areas in waters around Great Britain and Northern Ireland and Government is currently considering the findings of an independent review considering whether stronger protections should be introduced into whether and how Highly Protected Marine Areas (HPMAs) could be introduced into English water. The UK Government's commitment to marine protection forms a key part of the 25 Year Environment Plan[47].

PAUL NAYLOR

Appendix 4:
Nature Recovery Network: A sea view

ALEXANDER MUSTARD/2020VISION

A Nature Recovery Network is a joined-up system of places needed to allow nature to recover and thrive. It is a combination of the existing places where wildlife is more abundant, and the places where habitats need to be restored or created, to expand these remaining fragments and connect them up so that nature can recover. To be effective, it must extend across every part of the UK, including rural areas, coastal sites, cities and towns, and connect across boundaries with similar initiatives in the other UK countries and with the existing marine ecological coherent network.

The network will provide more spaces for wild species to live, feed and breed. It will allow plants, animals and seeds, to move from place to place and nutrient and water cycles to work effectively. It will enable the natural world to adapt to a changing climate and other pressures on the environment. Natural places where wildlife is abundant and where such ecological processes work well are vitally important for both the wildlife they sustain and the practical value they provide to society.

Legislation drivers for a Nature Recovery Network

A Nature Recovery Network mandated through an ambitious Environment Act would commit future governments to increasing the diversity and abundance of our wildlife, making it a bigger part of everyone's daily lives; and to improving the health of our air, soils, rivers, seas, and consequently, people.

This Act would build on the foundations of existing wildlife laws. It would be about nature's recovery and rebuilding society's connection to the natural world. It will need to ensure that regulation, investment, public spending and practical action work effectively together. While an Environment Act would reference future governments' environmental commitments on land and sea in England, the necessity to protect and promote recovery of the marine environment is already enshrined in several international conventions and national acts which the UK and devolved regions have ratified. These include:

- BERN Convention (1979).
- OSPAR Convention (1992).
- EU Marine Strategy Framework Directive which has been superceded by the UK Marine Strategy which largely performs the same function towards the same goals.
- Marine and Coastal Access Act (2009). England and Wales.
- Nature Conservation Act (2004) Scotland.
- The 25-year environment plan (England only).

An Ecologically Coherent Network of MPAs

The Wildlife Trusts are calling for a Nature Recovery Network to be enshrined in an Environment Act, and for similar networks for nature to be developed in the devolved administrations. The draft Environment Act at present only relates to the terrestrial environment in England but there is ongoing work by conservation coalitions to secure the inclusion of marine considerations in the Act. However, in relation to the marine environment, international conventions such as those described above, already describe in detail the need for an Ecologically Coherent Network at sea. The premise of Ecological Coherent Networks at sea and TWT Networks for Nature's Recovery envisioned for land (primarily) and sea are very similar.

What is an Ecologically Coherent Network of MPAs?

The OSPAR Recommendation 2003/3 for a Network of Marine Protected Areas aimed:
- to be ecologically coherent, including sites representative of all biogeographic regions in the OSPAR maritime area, and consistent with the CBD target for effectively conserved marine and coastal ecological regions;
- by 2016 to be well managed (i.e. coherent management measures have been set up and are being implemented for such MPAs that have been designated up to 2010);

which will:
- protect, conserve and restore species, habitats and ecological processes which have been adversely affected by human activities;
- prevent degradation of, and damage to, species, habitats and ecological processes, following the precautionary principle;
- protect and conserve areas that best represent the range of species, habitats and ecological processes in the maritime area.

OSPAR recognises that a network is characterised by a coherence in purpose and by the connections between its constituent parts. Networks can also be designed to be resilient to changing conditions. The following points can be identified as contributing to coherence:
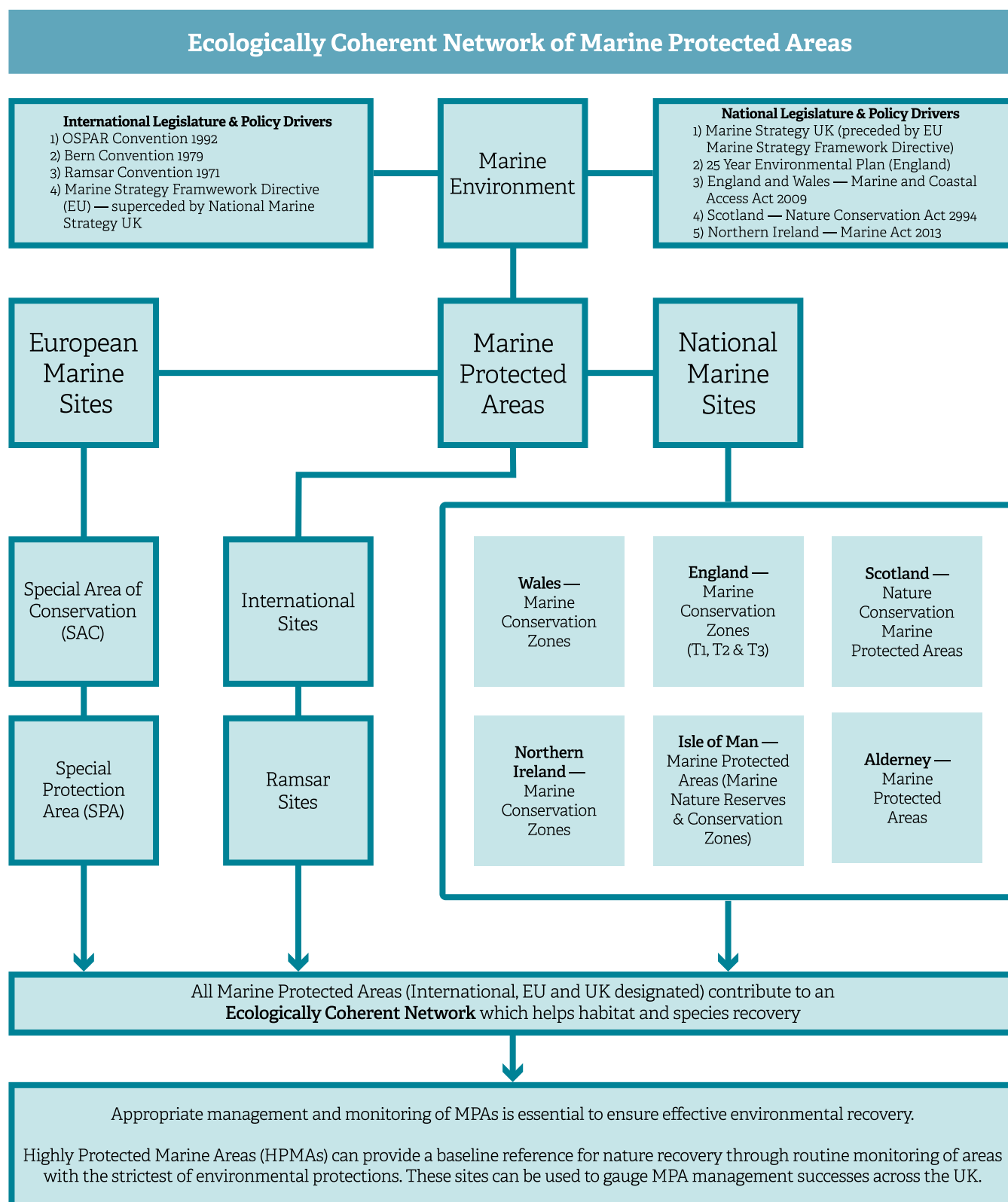- a network's constituent parts should firstly be identified on the basis of criteria which aim to support the purpose of the network;
- the development of an ecologically coherent network of MPAs should take account of the relationships and interactions between marine species and their environment both in the establishment of its purpose and in the criteria by which the constituent elements are identified
- a functioning ecologically coherent network of MPAs should interact with, and support, the wider environment as well as other MPAs although this is dependent on appropriate management to support good ecosystem health and function within and outside the MPAs.

Progress towards an Ecological Coherent Network of MPAs

The UK has not yet achieved an ecologically coherent network of well-managed Marine Protected Areas. However, to this end we have seen significant progress with designations on a national and international level including: 91 Marine Conservation Zones (MCZs), 42 Special Areas of Conservation (SACs), 47 Special Protection Areas (SPAs) and 97 Sites of Special Scientific Interest (SSSIs) in Secretary of State waters alone. Further MCZs in Wales and Northern Ireland as well as nature conservation MPAs in Scotland have been designated, all of which add to the UK wide network.

However, the MPAs need to be effectively managed and monitored if they are to achieve their conservation objectives. Furthermore, the MPA network must include a suite of Highly Protected Marine Areas (HPMAs) which offer the strictest levels of environmental protection from which we can learn what recovery of the marine environment looks like. We can also use the HPMA sites to inform best management practices for the rest of the network. The Wildlife Trusts are calling on Government to implement the recommendations listed in the Benyon HPMA review (2020) as soon as possible and commit to an ambitious HPMA delivery plan before World Oceans Day 2021.

ALEXANDER MUSTARD/2020VISION

Ecologically Coherent Network of Marine Protected Areas

International Legislature & Policy Drivers
1) OSPAR Convention 1992
2) Bern Convention 1979
3) Ramsar Convention 1971
4) Marine Strategy Framwework Directive (EU) — superceded by National Marine Strategy UK

Marine Environment

National Legislature & Policy Drivers
1) Marine Strategy UK (preceded by EU Marine Strategy Framework Directive)
2) 25 Year Environmental Plan (England)
3) England and Wales — Marine and Coastal Access Act 2009
4) Scotland — Nature Conservation Act 2994
5) Northern Ireland — Marine Act 2013

European Marine Sites

Marine Protected Areas

National Marine Sites

Special Area of Conservation (SAC)

International Sites

Wales — Marine Conservation Zones

England — Marine Conservation Zones (T1, T2 & T3)

Scotland — Nature Conservation Marine Protected Areas

Special Protection Area (SPA)

Ramsar Sites

Northern Ireland — Marine Conservation Zones

Isle of Man — Marine Protected Areas (Marine Nature Reserves & Conservation Zones)

Alderney — Marine Protected Areas

All Marine Protected Areas (International, EU and UK designated) contribute to an **Ecologically Coherent Network** which helps habitat and species recovery

Appropriate management and monitoring of MPAs is essential to ensure effective environmental recovery.

Highly Protected Marine Areas (HPMAs) can provide a baseline reference for nature recovery through routine monitoring of areas with the strictest of environmental protections. These sites can be used to gauge MPA management successes across the UK.

Figure 4: A network for nature's recovery at sea, brought about in legislation and in practice via Marine Protected Area designation and monitoringm will belp to form an ecologically coherent network across the UK for wildlife to use and benefit from

What does an ecologically coherent network of Marine Protected Areas mean?

Protection of key marine sites from damage is important in reversing decline. But research shows that the ecological benefits provided can be significantly increased if sites are built into a network. In this case, the total effect really does exceed the sum of the parts, but only if the network meets all of the criteria set out below.

1. Site selection

Sites should be identified for their range of habitats and species. Consideration should be given to species and habitats that are in decline, rare, or threatened, and to areas of high productivity.

2. Connectivity

Sites should be well distributed, but close enough to ensure ecological links are maintained so that fragmented habitats can recover.

3. Representativity

The full range of habitats and species found in the geographical area should be represented within the network and an adequate proportion of features should be included.

4. Resilience

Individual sites should be large enough to provide meaningful protection, and replicated to ensure a resilient network.

5. Management

Each site should be managed to ensure protection of the full range of species and habitats associated with it. There should be no damaging activities.

Figure 5: What does an ecologically coherent network of Marine Protected Areas mean? From the The Wildlife Trusts & The Way Back to Living Seas report

Appendix 5:
Ecosystem service maps

A number of services that society and the economy depends upon (e.g. water regulation, pollination, soil quality, recreation) are provided by natural systems[48]. This is a significant consideration in decisions relating to allocation and expenditure of public funds and the targeting of commercial, social, philanthropic and public investment. Nature Recovery Network maps will identify accurately where existing wildlife habitats are now and where they should be in future to sustain healthy natural systems. Mapping where nature is providing services to society and where there is a demand for such services, will show where investment in nature can not only help nature to recover but will help to strengthen ecosystem service provision. It will also provide better information to guide decisions that affect the natural environment, for example to protect areas that are important for certain ecosystem services from damaging development.

The Nature Recovery Network must form the basis of any further mapping — i.e. mapping natural capital and ecosystem services must be underpinned by an ecological network. The ecological network is what we need for nature's recovery whereas ecosystem services mapping shows how more resilient nature benefits society and can be used to engage various sectors in delivering the Nature Recovery Network.
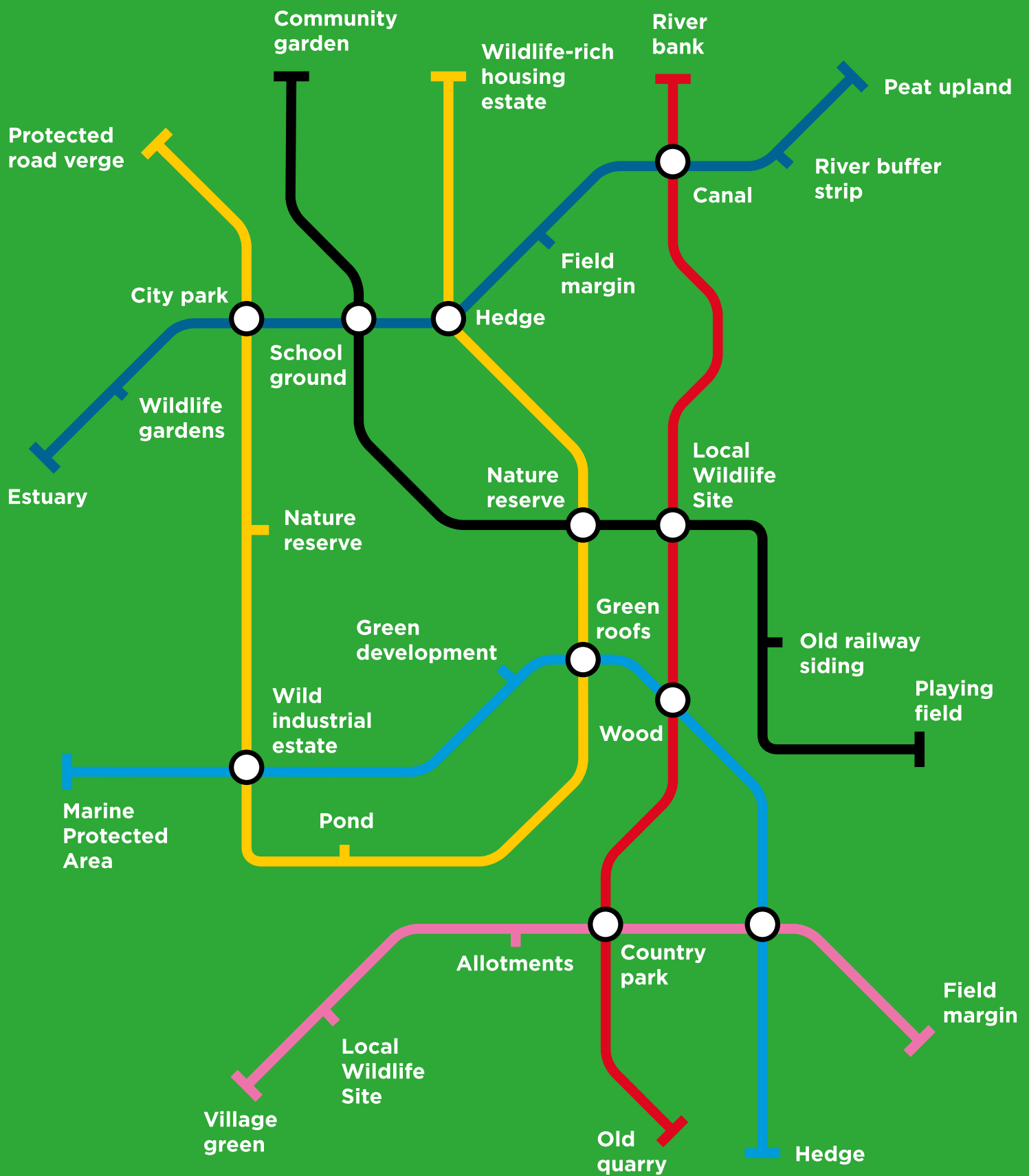
This ecosystem service mapping should be a separate layer of mapping that can overlay the Nature Recovery Network maps to enable analysis of the relationships and interactions between large and complex datasets covering social, economic and environmental factors.

A software model would be used to identify where nature is already delivering services and where new habitat is needed to deliver essential services. These models make use of social and environmental data, for example cross-referencing areas of health inequality, air quality and tree cover, to identify where tree planting could alleviate the impacts of air pollution. For example, EcoServ-GIS is a Geographical Information Systems toolkit for mapping ecosystem services at the county scale, which has been developed for and tested by The Wildlife Trusts. It can map supply and demand for air purification, flood water storage, water purification, carbon storage, local climate amelioration, noise regulation, pollination, accessible nature, green travel and nature as an educational resource.

Developing the maps in partnership with the stakeholders that will use them would increase understanding of how nature is linked to their organisations' objectives. This could increase support for investment in its recovery.

Some ecosystem service models map each service separately. The resulting maps can then be overlaid on the Nature Recovery Map, individually or in combination, to inform decisions that affect nature's ability to provide certain services and show where enhancement or creation of new habitat would strengthen the provision of these services. This makes it possible to identify areas which deliver multiple services, but it should be recognised that more is not necessarily better – sometimes a single service is of primary importance to society.

The Local Nature Recovery Network map and the suite of ecosystem service maps should be available together, for example on a website. It should be possible to view the map for each ecosystem service as an individual layer superimposed on the Nature Recovery Network map. Different services would be of interest to different audiences and these maps would enable those audiences to target activity or investment in places of most relevance to their interests.

Community garden

Wildlife-rich housing estate

River bank

Peat upland

Protected road verge

River buffer strip

Canal

City park

Field margin

School ground

Wildlife gardens

Local Wildlife Site

Estuary

Nature reserve

Nature reserve

Green roofs

Green development

Old railway siding

Wild industrial estate

Playing field

Wood

Marine Protected Area

Pond

Allotments

Country park

Field margin

Local Wildlife Site

Village green

Old quarry

Hedge

Hedge

No matter where you live in the UK, there is a Wildlife Trust inspiring people about the natural world. Each day we work to save, protect and stand up for the wildlife and wild places near you.

Supported by more than 850,000 members, we take action for insects on our 2,300 nature reserves, through our work with landowners, farmers and policy makers, and by encouraging everybody to look after insects where they live. We hope that you will join us.

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