Overarching Topic

Large-Scale Nature Recovery and Restoration

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Rebuilding nature
Good practice guidance for ecological restoration

CIEEM

This document is part of a series written by members of CIEEM's Ecological Restoration Special Interest Group. The series is prefaced by ten good practice principles for ecological restoration, set out in *Rebuilding nature: Good practice guidance for ecological restoration,* and includes five Overarching Topics that apply to any ecological restoration project in the terrestrial, freshwater and marine environments of the UK and Ireland:

- **Integrating Ecosystem Services into Ecological Restoration**
- **Project Planning and Implementation**
- **Physical Environment**
- **Large-Scale Nature Recovery and Restoration**
- **Monitoring**

Accompanying the five Overarching Topics are the habitat specific documents applicable to ecological restoration projects in terrestrial, freshwater and marine environments.

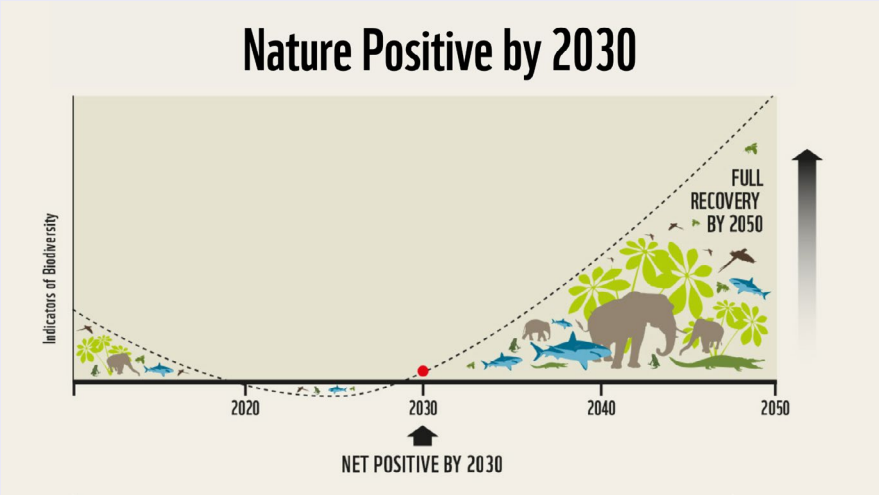
Large-Scale Nature Recovery and Restoration

Description and Context

Nature recovery is essential for our survival, prosperity and well-being. Urgent action is clearly needed as outlined by both the Global Biodiversity Framework (GBF) agreed in Montreal and the UN Decade on Ecological Restoration. Nature recovery in its broadest sense is best described as a restoration of ecological processes. The aim is to halt a decline in biodiversity and progressively reverse the loss to deliver a positive trajectory. This bending curve of biodiversity loss is now exemplified by the goal of achieving a Nature Positive world by 2030 through restoring ecosystems (**Figure 1**). The goal of nature recovery will increasingly be presented at the national scale. National Biodiversity Strategies and Action Plans (NBSAPs) and other strategic documents (some of which are already in place), with legal targets for governments, will codify the GBF for each country or jurisdiction. Given the urgency, increasing the scale and pace of our approach is crucial for successful delivery. Critical elements are defined in **Box 1**, demonstrating collaborative working, dialogue, and thinking beyond site boundaries.

Figure 1

The trajectory towards the global goal of nature positive by 2030 recognises some ongoing loss because of current trends and presents a goal for net improvement by 2030 (compared to 2020) and full recovery by 2050.



Nature Positive

The UK Statutory Nature Conservation Bodies (SNCBs) published a joint statement (JNCC, 2022) on nature recovery and identified nine actions, effectively describing what it looks like to deliver nature recovery goals by 2030:

- ☐ Restore and create habitats to strengthen nature networks (see CIEEM Rebuilding Nature: Good practice guidance for ecological restoration for definitions)
- ☐ Develop the evidence base to support transformative action
- ☐ Develop the market for green finance investment in nature recovery
- ☐ Deploy Nature-Based Solutions by default
- ☐ Adopt targets to become Nature Positive

- Improve the management of protected areas on land and sea
- Integrate outcomes for nature into development plans on land and sea
- Better conserve wildlife habitats outside of protected areas
- Tackle atmospheric and diffuse water pollution

Ireland's National Parks and Wildlife Service Strategic Plan 2023-25 and Minister Malcolm Noonan's October 2024 announcements for implementation of the EU Nature Restoration Law are similar but less specific.

This Overarching Topic, in conjunction with other topics and sections, will aid delivery of nature recovery and restoration at large scales.

Figure 2

The Lune Valley with its dynamic channel, oxbows and complex environment in north Lancashire and Cumbria. A number of large-scale approaches are in evidence. These include a Catchment-Based Approach, Nature Improvement Areas, and species recovery work amongst others.

Photo credit: Tim Graham

Large scale: landscape to seascape

The development of large-scale approaches to nature conservation has been driven by a recognition of the ongoing impacts on the environment revealed over previous decades. Recognition of the need to expand efforts beyond protected sites and to take action over larger areas has helped steer action and strategy (Lawton *et al*., 2010; Maxwell *et al*., 2020; UK Biodiversity Partnership, 2007), and has led to various large-scale initiatives for action (Royal Society of Wildlife Trusts, 2006; RSPB, 2001; Saunders & Parfitt, 2005). Various motivations have been emphasised during the evolution of these approaches, with common elements being (from Eigenbrod *et al*., 2016):

- To tackle the impacts of habitat fragmentation and degradation
- The need for climate adaptation and amelioration
- To reverse environmental homogenisation
- To restore to wilder states

- To access and release services and benefits to society that restoration can increase

What can be defined as 'large-scale' has often been based on landscape-scale terrestrial delivery, but such definitions are also relevant for delivering nature recovery in any environment. They incorporate large areas, often delivering multiple benefits, with strong collaboration, which drive nature's recovery by restoring natural processes and connecting resilient networks (The Landscape Partnership, 2015). This definition requires further detail beyond general principles.

This topic uses the term 'large-scale' to cover freshwater, terrestrial or marine environments (and their transitional rather than strict boundaries). **Box 1** explores a more nuanced definition of large-scale restoration and nature recovery, covering the key elements found across relevant initiatives, though note that not all are consistently or equally present. Importantly, our definition is used to recognise factors beyond a single site / species and often crosses multiple scales and assemblages of species. The long history of terrestrial landscape-scale approaches provides useful insights applicable across all environments (Adams *et al*., 2016; Donaldson *et al*., 2017). Recent decades have seen catchment approaches being established and contributing widely, while seascape-based initiatives are receiving increasing levels of focus (Pittman, 2018). Across all environments, there are similarities and differences that require consideration, which are summarised in **Table 2** in the *What to Consider* section below.

Box 1

Critical Elements Defining Large-scale Restoration and Nature Recovery

- Demonstrates thinking beyond the site at scales relevant to define successful outcomes i.e. covers large scales, whether spatial (500ha+), temporal (10yr+), or institutional.
- Demonstrates actively incorporating spatial planning and ecological network / systems thinking.
- Considers wider benefits and trade-offs through taking a natural capital / ecosystem services approach.
- Involves collaboration, partnership and dialogue between organisations and with communities.
- States clear goals, targets or assumptions about what will be restored, by when, and what will be the contribution to nature recovery at local, regional and/or national scales.

Restoration and rewilding

Rewilding and restoration (see CIEEM Rebuilding Nature: Good practice guidance for ecological restoration for definitions) both have relevance for large-scale action (Du Toit & Pettorelli, 2019; Monsarrat *et al*., 2022). They are becoming increasingly complementary, especially as ecological restoration has developed to focus on complexity and resilience (Bullock *et al*., 2022; Lindenmayer *et al.,* 2008; Fischer *et al.,* 2021). Elements of both are critical to delivering large-scale nature recovery (Pettorelli and Bullock, 2023).

A core component of ecological restoration has traditionally been the 'native' reference ecosystem / state. This provides the comparison against which trajectory, goals and targets can be measured. Climate change presents challenges for the application of reference ecosystems, a topic which has been raised for some time (Harris *et al.*, 2006). The discussions about wider complex environmental change and degradation (Du Toit and Pettorelli, 2019, Corlett, 2016) raise further questions on the relevance of the approach. In the UK and Ireland, where pre-disturbance reference ecosystems no longer exist, the challenges are more acute and require the careful exercise of judgement as to where and when reference ecosystems are used, with clarification of the future relevance of any reference and how it matches the requirements of a scheme's goals (Coleman *et al.,* 2020).

In practice, these considerations have brought the goals of ecological restoration and rewilding closer. Both approaches look at the target of self-sustaining ecosystems and restored natural processes at scale, and both also discuss future conditions and environmental states. The principle of 'restoring forwards' is an approach reinforced by an increased desire to secure future ecosystem resilience (Weise *et al.,* 2020) and is considered to be fit for both current and future needs (as used in forest landscape restoration (IUCN, 2019)).

Ireland and the UK provide a more culturally modified context for rewilding, where the emphasis is different to that found in the USA (see Soule and Noss (1998) for the US approach). In contrast to the 'wilderness' of parts of the USA, the landscapes of the UK and Ireland have been managed for centuries and are therefore heavily culturally modified. Shepers and Jepson (2016) suggest that rewilding in Europe is "about moving up the scale of wildness within the constraints of what is possible" and should be approached by restoring natural processes and dynamics to create self-sustaining, robust ecosystems that provide resilience to external threats and pressures, including the impact of climate change. This approach can now be found in the internationally agreed *Guiding Principles for Rewilding* presented by the IUCN Commission for Ecosystem Management (Carver *et al.,* 2021).

Figure 3

Dorset landscapes: [a] modified and productive agricultural landscape, and [b] more dynamic restored nature recovery focused landscape. Both are adjacent and opposite sides of the same watercourse.

Photo credit: Tim Graham

a

b

Importance

The UK and Ireland have seen a continuing decline in the quantity and quality of wildlife habitats, so a more concerted and integrated response to nature recovery is needed. This is especially important as society faces biodiversity and climate emergencies (see CIEEM's Climate Emergency & Biodiversity Crisis: Declaration and Call to Action 2019).

The International Panel on Biodiversity and Ecosystem Services (IPBES *et al.*, 2018) highlights the critical links between nature recovery, action at large scale, and the ecosystem services that benefit society (see Integrating Ecosystem Services into Ecological Restoration overarching topic for more detail). The announcement of the UN Decade on Ecosystem Restoration has globally shone a light on the critical role our actions in the run up to 2030 have in preventing, halting and reversing the loss of nature. Our actions contributing towards nature recovery are also part of the necessary path to sustainable development (see UNEP's Becoming #GenerationRestoration), something emphasised by the IUCN strategy Nature 2030: One Nature, One Future (2021) and within the Global Biodiversity Framework's (GBF) mission to put nature on the path to recovery. This will only be achieved through clear integration of actions into wider landscape and seascapes across a range of goals and targets (e.g. GBF Goal A: Protect and Restore and GBF 2030 Targets 1, 2, 3 and 4).

The critical role of ecosystems and nature recovery in our continued prosperity was evidenced by the Dasgupta Review (Dasgupta, 2021), placing resilient ecosystems as central to everyone's business. However, as pointed out in the Convention on Biodiversity Diversity (CBD) Global Biodiversity Outlook 5 (2020), evidence has suggested that the current pace and scale of action is not enough to deliver the changes necessary to achieve international goals. A much faster pace of ecological restoration is needed, at a larger scale, to achieve national and international goals and targets, including achieving full nature recovery (see Leclère *et al.,* (2020) for the broad array of actions set out at the international scale). The UK's *State of Nature Report* (Burns *et al*., 2023) repeats the conclusion, demonstrating the need to increase the rate and scale of restorative action to improve habitat and species.

Across the UK and Ireland there are various top-level government commitments to nature recovery. The UK government committed to being the first generation to leave the environment in a better state than it was found (as set out in its 25 Year Environment Plan, and continued in the update and revision presented within the current Environmental Improvement Plan 2023). Scotland's Tackling the Nature Emergency - Scottish biodiversity strategy to 2045 lays out a clear aim to restore and regenerate biodiversity by 2030. In Wales The Nature Recovery Action Plan for Wales 2020-21 is due for update every four years. Ireland has also outlined its commitments to improving the state of biodiversity in Ireland's 4th National Biodiversity Action Plan (2023-2030). The Northern Ireland Biodiversity Strategy to 2020, which recognises biodiversity enhancement as a duty under the Convention on Biological Diversity, also remains overdue for renewal.

The *Nature Recovery – Joint Statement* by the UK SNCBs (JNCC 2022), along with the accompanying evidence report (Brotherton *et al.,* 2022), communicated the consistent and coordinated goals for nature recovery. Goals are more focused around creating a large-scale nature network building on better, more resilient protected areas and an increased area of networked wildlife habitat. There is also an emphasis on how areas outside of the protected site network will be important through Other Effective area-based Conservation Measures (OECMs) (see **Table 3** for a definition). Across all nations there is an increase in strategic and integrated planning, with many nations having or developing statutory targets relevant to nature recovery (**Table 1**) and spatial approaches to large-scale recovery, often termed 'Nature Networks'.

Table 1

A summary of national approaches to nature recovery in the UK and Ireland.

Key legislation, approaches to nature recovery, legal targets, and nature networks.

Nation	Approach
England	Environmental targets are established through several key frameworks: the Environment Act 2021 which sets specific Environmental Targets (Biodiversity) (England) Regulations 2023, the National Planning Policy Framework, Environmental Land Management schemes, and policies outlined in the Environmental Improvement Plan (EIP) 2023. The EIP sets out an aim for environmental net gain (currently limited to mandatory Biodiversity Net Gain), Nature Recovery Network, Marine Net Gain, legal targets and associated interim targets, Local Nature Recovery Strategies and the Environmental Principles Statement. **See also Natural England documents:** Nature Networks Evidence Handbook (NERR081) | Ecologically connected network think piece (NECR467) | Green Infrastructure Framework **and Gov. UK's** National Design Guide 2021
Wales	The Well-being of Future Generations (Wales) Act 2015 and Environment (Wales) Act 2016 set an important foundation for environmental action in Wales, embedding consideration of impacts on future generations and resilience within Welsh legislation. The Nature Recovery Action Plan sets out national priorities, last updated 2021. Wales has adopted a 'Net Benefit for Biodiversity' approach which uses a DECCA framework (Diversity, Extent, Condition, Connectivity and Aspect of ecosystem resilience), along with national and local Nature Recovery Plans. An overall goal of *A Resilient Wales* (L. Jones, 2023) can be supported by protecting and providing sufficient scale, extent, diversity and connectivity within, and between, landscapes and habitats to maintain and enhance biodiversity and the resilience of ecosystems as emphasised in Planning Policy Wales 12th Edition (2024) and Future Wales: the national plan 2040. An Environment (Principles, Governance and Biodiversity Targets) (Wales) Bill was introduced in June 2025. **See also: Natural Resources Wales's** Practitioners' Guide to Resilient Ecological Networks
Scotland	The Scottish Biodiversity Strategy to 2045 (Scottish Government, 2024) sets out a clear ambition for Scotland to be Nature Positive by 2030, and to have restored and regenerated biodiversity across the country by 2045. It is supported by a series of 6-year rolling Biodiversity: delivery plans 2024 to 2030 which include a comprehensive set of cross sectoral actions. As part of the Strategy, NatureScot has produced the 30 x 30 Framework, Nature Networks framework and Nature30 sites, and work is underway to identify opportunities for Nature Restoration at Landscape Scale. In the Natural Environment Bill (Scotland) Scottish Government must set legally binding targets for nature restoration. This Bill expected to become law before the Scottish election which is due by May 2026. Scottish Government's National Planning Framework 4 (2023) Policy 3b is set out to ensure most developments will only be supported where it can be demonstrated that the proposal will conserve, restore and enhance biodiversity, including nature networks, so they are in a demonstrably better state than without intervention. NatureScot are currently developing A Biodiversity Metric for Scotland's Planning System to support this policy. **See also NatureScot publications:** Nature Networks Interim Guidance for Local Authorities | Ecological Networks Protected Areas Review

Northern Ireland	Despite the Government's declaration of a Climate Emergency and commitment to reversing biodiversity decline, there is no statutory target framework equivalent to those in other UK nations. A Private Members' Nature Restoration Bill, proposed and consulted on in 2025, is seeking to establish legally binding restoration targets and frameworks. The Environmental Improvement Plan 2024 sets out aims to expand and improve protected and connected land for nature, enhance protected site condition, and support the global 30 x 30 target. However, there is currently no legislation mandating Biodiversity Net Gain (BNG) or equivalent measures. Although BNG is being increasingly referenced in policy discussions and planning guidance, there is no clear mechanism to act upon it without amending the Strategic Planning Policy Statement Planning For Sustainable Development 2015. The Northern Ireland Peatland Strategy to 2040 sets five objectives and 26 actions for peatland conservation and restoration. However, the actions mostly relate to development and implementation of other policies, and not directly to restoration of peatlands. **See also Ulster Wildlife documents:** Nature Recovery Networks for Northern Ireland | Developing Habitat Networks in Support of a NI Nature Recovery Network; **Wildlife & Countryside Link**: 30by30 2025 UK Progress Report; **and Environment Links UK**: 30x30: Land and Sea for Nature's Recovery Briefing 2021
Republic of Ireland	As part of the EU, Ireland is now covered by the recently adopted EU Nature Restoration Law; this obliges Ireland to produce a national Nature Recovery Plan by 2026 and, eventually, statutory targets for ecosystem restoration. This is also an Outcome (2F) of Ireland's 4th National Biodiversity Action Plan 2023-2030. Other outcomes relate to the restoration of peatland (2C), marine and freshwater (2D), and the wider landscape (2B and 2A). Local planning authorities have varying approaches to biodiversity protection and enhancements through their local planning policies, including promoting ecological networks and adoption of the policy of No Net Loss or Biodiversity Net Gain for development. Legal targets have not been proposed by Government, but are recommended in reports (Joint Committee on Environment and Climate Action, 2023). **See also:** Dún Laoghaire-Rathdown County Ecological Network Map | Environmental Protection Agency Report 188: Integrating Ecosystem Approaches, GI and Spatial Planning | Irish Wildlife Manual No 95: National Ecosystem and Ecosystem Service Mapping Pilot for a Suite of Prioritised Services

Figure 4

Arnside and Silverdale network management work for butterflies by Butterfly Conservation as part of the Nature Improvement Area. Based on an ecological network approach, the management enabled functional connectivity and resilience to be built across the landscape.

Photo credit: Tim Graham

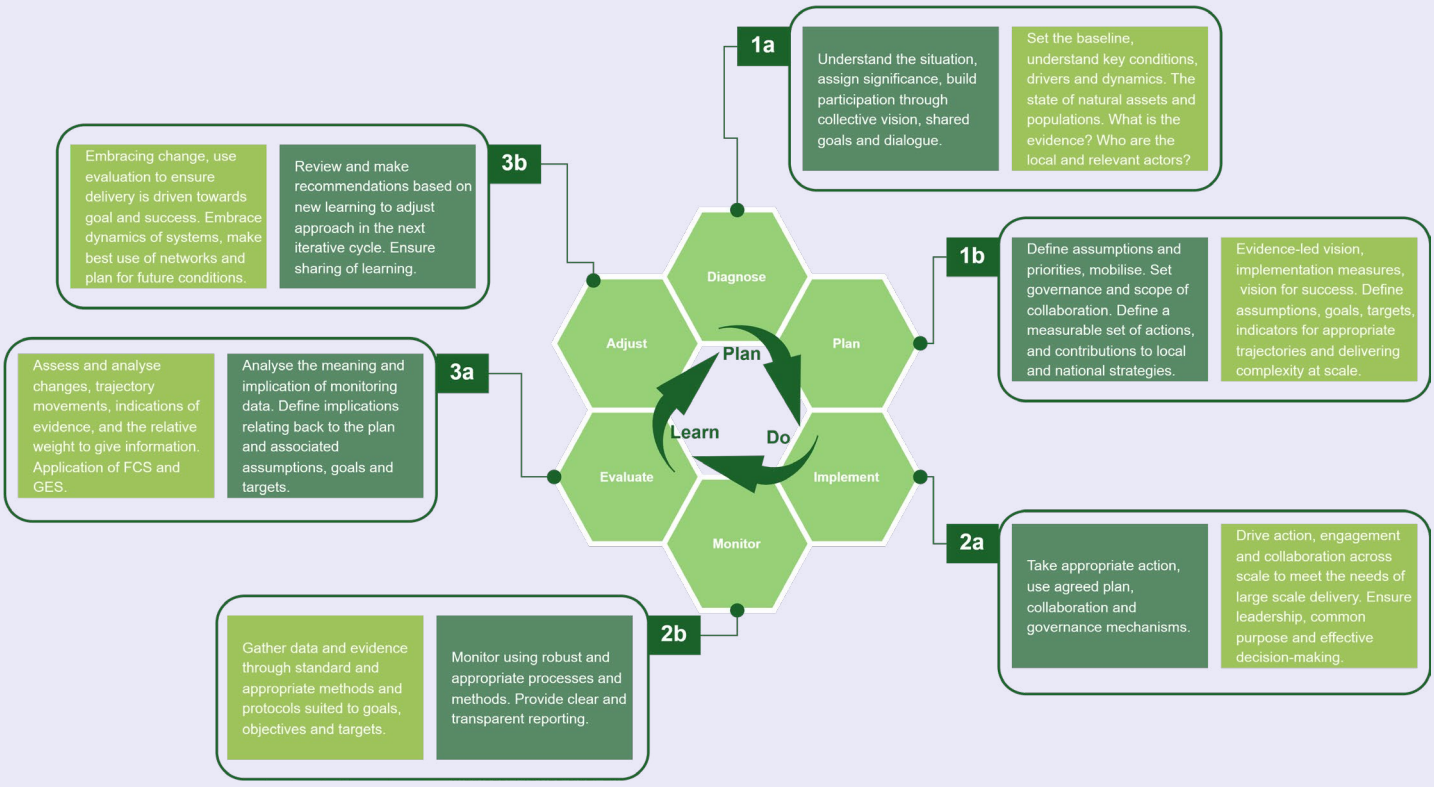
What to Consider – Methods and Measures

The nature of large-scale restoration and recovery makes adaptive management a critical part of any approach and fits with current standards of practice (examples are Gann *et al.* (2019), Conservation Measures Partnership and Nelson *et al.* (2024)). Adaptive management is a tool to enable a logical approach where there are high levels of uncertainty and complexity presenting long-term challenges to delivery. Outcomes can be better secured through a cycle of monitoring and decision-making that builds a framework around the well-known model Plan-Do-Learn (**Figure 5**).

The guidance in the following sections extends and amalgamates information from areas of ecology relevant to large-scale restoration for nature recovery. The long-term, complex and sometimes unknown nature of future interactions at scale make it particularly important to use an adaptive approach. The six stages of adaptive management present a logical flow to explore the considerations and good practice guidance for large-scale nature recovery and restoration.

Figure 5

The adaptive management cycle. Outlining the six stages that make up the overall Plan-Do-Learn system that forms the basis of adaptive management planning. Dark green boxes represent the more general approach for the relevant phase, and light green boxes represent the more specific approach for use in large-scale recovery schemes.



1a: Diagnose

The Recovery Area

The type of ecosystems and environment that are targeted for recovery influence the action needed for restoration. Over the coming years there will be greater exploration of 'wholescapes' (examples from Natural Capital Initiative Wholescape Thinking Guidance Note and British Ecological Society (BES) The Future of Ecological Research in the UK) as a way to further increase scale and overcome institutional and other barriers to the scale and pace of delivery needed for nature recovery. While this field develops, we focus on three arenas that define approaches for large-scale restoration, but which also often unavoidably interact: Landscape, Catchment and Seascape.

Large-scale restoration experience is informed disproportionately by work on land (terrestrial or freshwater systems) rather than the sea (marine). This is changing with more recent delivery via large-scale marine partnerships. Importantly, the principles and learning from any environment are often applicable for any partnership restoration project. **Table 2** summarises factors for consideration in large-scale nature recovery. Some aspects are common across any large initiative, while others are far more particular to the system(s) involved; for example, differences in connectivity dynamics, or number of dimensions and gradients to consider. As a simple guide, the following categories can aid ecological definition of a relevant restoration area (**Box 2**):

- **Vision**. This is usually relevant to a future states and progressive solution in the long term. Examples include Coastal Management Plans with visions into the 50-100 year timeframe.
- **Partnership or Institution**. The extent and influence of a specific lead partnership or institution defines the area. The complexity, importance or iconic sense of place may have defined such organisations for the purpose of restoration. The IUCN UK Peatland Programme is a great example covering the UK (see collaborative partnership, **Box 2**).
- **System**. Increasingly common, the area defined by a particular system, often defined by catchments (e.g. Catchment-based Approach partnerships) and wider environmental parameters or benefits. More commonly found as source-to-sea models in recent years.
- **Restoration Purpose**. The area involved is defined by the ecosystem or focal species involved; it may be linked to a past extent or mix with the Partnership (above) area to provide greater scales of impact, coordination and standards (for example the Alliance for Scottish Rainforest or the Great Northern Bog).
- **Nature Networks**. Often defined at a local geographic scale, these areas are defined by groups of network elements, important sites, opportunity areas, land owners and, increasingly, national approaches to nature conservation (see **Table 1**, above; and it fits closely with the land ownership model outlined in **Box 2**).
- **Investment**. As nature finance develops, there is an increasing interest in standards and assurance of restoration projects and programmes. These need to meet investors' expectations on returns, but also on quality and the scale of investment. This has meant that pipeline development and new forms of investment coordination are currently under development.

Baselines, trends, conditions and assets

Any work on nature recovery and restoration requires an understanding of what has been driving decline and degradation. Current, past and predicted future conditions are important. Knowing how drivers and pressures affect the current, historical and potential future natural assets (physical environment, species and habitats) in the area will indicate the implementation measures for consideration when planning for restoration. Sources of baseline data may be:

- Partners, national and local datasets (e.g. breeding birds or NBN Atlas data)
- Specific evidence-gathering for the initiative over previous years
- Historical mapping and policy documents from Local Authorities (e.g. Biodiversity Action Plans, Recovery Plans, Local Nature Recovery Strategies)

- Environmental Non-Governmental Organisations (eNGOs) (see large-scale initiatives such as Cairngorms or Cumbria Connect, and previously Futurescapes and Living Landscapes)
- Programmes supported by funders such as National Lottery Fund Landscape Connections
- National documents (e.g. National Character Area Descriptions)

National approaches often define ecological networks as a key aspect of nature recovery (see **Table 1**). A critical part of planning large-scale restoration and recovery is understanding the components of ecological networks, such as core areas, restoration areas, corridors, connectivity and buffer areas (see **Table 3** for definitions). It is important to understand how the current ecological network is formed, whether it is functioning, and what objectives may be relevant to increasing its resilience. The concepts cover terrestrial, freshwater and marine environments, but require slightly different thinking about what factors define effective approaches for each of the components. For example, viable populations and their dynamics operate within different restrictions, pressures and threats, scales and dynamics.

It will be important to diagnose the components of functioning ecological networks, and their species assemblages, in terms of any declines or increases in numbers or condition. Understanding the sensitivity of a species or habitat can help to prioritise and profile the measures needed. This kind of thinking is already part of national policy in many jurisdictions, taking a strategic network and planning approach to enable a robust large-scale methodology for conservation and restoration (for background, see Margules and Pressey, 2000). While guidance and the level of implementation varies across countries, their presence is clear across the UK and Ireland, as detailed in **Table 1**. It is also highly applicable to green infrastructure in urban areas (see Natural England's Green Infrastructure Framework, Ireland's Environmental Protection Agency Report 188: Integrating Ecosystem Approaches, GI and Spatial Planning and quality assurance methods such as Building with Nature).

Table 2

Comparison of common factors and requirements across environments (terrestrial, freshwater and marine) for large-scale restoration and recovery.

(Synthesised from Lawton *et al.,* 2010; Eigenbrod *et al.,* 2016; Pittman, 2017; Lindenmayer *et al* 2008; Geist and Hawkins, 2016; Harvey and Henshaw 2023; Wohl *et al* 2021; Cooke *et al.,* 2022; Suding, 2011; Skidmore and Wheaton, 2022; Peipock *et al.,* 2015; McAfee *et al.,* 2022, Boulton *et al.,* 2013, Underwood *et al.,* 2021)

All Environments		
☐ Easier to work with nature at scale, restore natural processes (including flows) and provide space and freedom to change ☐ Heavily modified environments and environmental change make relevant future trajectories and goals difficult ☐ Need to understand species abundance / availability, sensitivity and recovery / recolonisation ☐ Require target state and trajectory goals to be specified – clear goals and targets ☐ Importance of biological influences on ecosystem recovery and complexity ☐ Focal species are critical component of restoration and recovery at scale ☐ Success requires future relevance, clear communicated assumptions, adaptive approach and long-term trajectory goals ☐ Long-term and large-scale restoration or recovery balanced with other uses of system		
Landscape or Terrestrial	Freshwater and River	Seascape or Marine
☐ Less need to tackle drivers / pressures ☐ Functions operating at various scales ☐ Greater evidence for rewilding outcomes at large scales ☐ Dynamics limited and space limited ☐ Patch-matrix present, mosaic is focus ☐ Often highly habitat-orientated ☐ Broad participatory and community interest ☐ Importance of configuration ☐ Multiple regulatory regimes depending on specific area	☐ Work across system boundaries ☐ Tackle drivers and pressures ☐ Greater scope for active restoration ☐ Catchment scale functions ☐ Site / reach to catchment scale ☐ Continuum for rivers to freshwater / wetland corridors ☐ Dynamics highly restricted ☐ Patch-matrix present with mosaic at some upper reaches ☐ Broad participatory and community interest ☐ Importance of barriers, rooted vegetation and insects ☐ Specific regulatory regime for rivers and river basins	☐ Greater dispersal and connectivity scales / distances ☐ Relevance of natural recovery processes ☐ Requirement to tackle drivers and pressures for successful restoration ☐ Functions at largest scale ☐ Restoration moving from habitat basis to seascape scale ☐ Space is usually present ☐ Coupling of benthic, coastal, pelagic and surface systems required ☐ Dynamics highly present ☐ Patch-mosaic structure present ☐ Restricted participatory and community environment ☐ Specific regulatory regime with relevance for inshore and offshore

Focal species – using the disproportionate importance of species

In restoration and recovery, the weighting of species value can be evidenced or judged to be more important. For example, some species define their ecosystems, some have a disproportionate structuring impact with complex interactions, and some are useful for the practical considerations of communicating and undertaking restoration. Consideration should be given early to understand if there are relevant Focal Species (see **Table 3** for a range of useful definitions).

It is also important to understand the wider context that influences a species' presence and persistence. Successful ecosystem recovery and restoration relies on a thorough understanding of the factors that influence the presence of species, collectively referred to as Assembly Rules. This includes factors such local species pools, dispersal, colonisation and extinction events, the wider environment, and interactions amongst constituent species (Funk, 2021).

The ability of species to enable recruitment of others, or to inhibit establishment, creates disproportionate impacts for those arriving early as an ecosystem is reassembling. These Priority Effects add another level of complexity for any large-scale delivery because of increasing network interactions. These complex interactions also mean benefits to one set of functional groups will not necessarily benefit others (Pocock *et al.,* 2012; Thornhill *et al.,* 2018), indicating the need for complex planning for networks of ecosystems at various successional stages. These factors need to be diagnosed to enable evidence-based decisions on what species recovery will require in terms of species focus and specific measures. It is critical for restoration initiatives to include any species determined as priorities as a result of their impact on target ecosystems. Details of various focal species definitions and assembly rules can be found in **Table 3**.

Figure 6

Glen Alladale provided a large-scale restoration and rewilding rallying cry in the early 2000s by prompting conversations about how to reintroduce apex predators to Scotland.

Photo credit: Tim Graham

1b: Planning

The evidence from diagnosis is used to develop a clear vision for success (with clear assumptions) along with any goals and targets relevant to restoration or recovery. It will propose appropriate scales and measures to implement; indicators for appropriate trajectories; and / or how large-scale complexity is to be delivered; and its contributions to strategic approaches (e.g. nature networks) and national statutory targets for nature recovery. Resilience must be designed into a scheme, along with relevant spatial planning and complexity.

Build resilience and recovery

In the long-term, and at large-scale, restoration and rewilding aim to create self-sustaining and evolving systems (Carver *et al.,* 2021; Cooperrider and Noss, 1994). This recovery endpoint works better with natural processes and minimises or ends interventions in the future, but some species or ecosystem recovery will require local level stewardship and

intervention (R. Jones *et al.,* 2023). The diagnosis will indicate what actions, measures and interventions are needed, and will require planning – more so in the shorter-term, due to the nature of our modified systems, the pressures and multiple uses of our environmental systems, and the pace of environmental change and / or degradation.

The concepts of resistance and resilience (see **Table 3** for definitions) describe the sensitivity of an ecosystem or its features (e.g. species, habitats, assemblages) and can be important to better understand priorities within any plans for nature recovery (see Natural England's English Seabird Conservation and Recovery Pathway – Seabird Sensitivity Evidence Review (NECR456) as an example). It may be possible to find relevant information through local or regional versions of Birds of Conservation Concern, in state of nature reports or in natural capital assessments.

The Lawton Review (Lawton *et al.,* 2010) was published as a review for the terrestrial environment in England but is relevant anywhere as a call to action: Better, Bigger, More and Joined. It drives action to increase ecological resilience in two ways (Isaac *et al.,* 2018):

Better and Bigger	This action supports larger and more populations of species through improvements in habitat quality and extent.
More and Joined up	More habitat creation and connectivity measures help overcome impacts on wider population dynamics and range shifts.

The relative requirements of *Better*, *Bigger*, *More* and *Joined up* in any given area depend on the location and ecological context. Connectivity is particularly complex in terms of how to create more habitat and join it up effectively (Baguette *et al.,* 2013), and species have different requirements for foraging, breeding, dispersal and home range that influence the requirements in terms of habitat patch size and type (Szangolies, 2022). Context is important, with increasing connectivity potentially having negative impacts through the movement of invasive species, and the comparative value of small patches versus large not being straightforward (Riva and Fahrig, 2022). This part of planning relates back to the ecological networks and national approaches mentioned earlier (see Baselines, Trends, Conditions and Assets, page 11) to allow initiatives to coordinate at greater scales and implement the Lawton principles as part of nature recovery measures.

Planning for complexity and recovery across scales

Working with and understanding complexity in ecological systems is a critical component for nature recovery and large-scale restoration. A summary of elements that enable greater complexity to be embedded is outlined below (summarised from across Bullock *et al.,* 2022; Carver *et al.,* 2021; Coleman *et al.,* 2020; Corlett, 2016; Perino *et al.,* 2019; Turner and Seidal, 2023):

Systematic Planning	Integration across different programmes of actions that contribute to restoration and nature recovery (e.g. regenerative agriculture). Identify disproportionately important species, processes and elements of the ecosystems, including incorporation of dispersal, trophic interactions and disturbance as processes. As scale of delivery increases, so does the importance of system thinking (see Physical Environment Overarching Topic) and systematic planning (something that can better integrate ecosystem services, see Integrating Ecosystem Services Overarching Topic).
Change and complexity	Manage for change (stochastic and deterministic) and across multiple scales. This includes for climate change, trade-offs and displacement impacts. Also understand inevitable time lags between events and consequences.
Integration & definition of action	Integration across aquatic and terrestrial systems; use and define conceptual models appropriate to objectives, and define a functionally and / or physically connected environment for action as the location of activities. Define appropriate and proportional collaboration and partnership arrangements.

As scale of delivery increases, natural processes and interactions become more important and increasingly complex. Restoration and nature recovery initiatives must balance implications for dynamics, drivers and pressures, as well as species ecology, as important factors often change depending on the scale used. Requirements for terrestrial, freshwater and marine environments differ in how scale is considered. Freshwater and rivers require greater integration across different scales (Piczak *et al.,* 2023) and there is a need to understand dispersal and connectivity within a different order of magnitude of scale within marine systems (Geist and Hawkins, 2016).

Scales are also both spatial and temporal. Recovery is a temporal consideration, as are aspects of changing behaviours of species throughout their life history. Ecosystem processes and function change over time, as do populations of species. These components interact to determine recovery trajectories. Recovery timescales and resilience should be defined in the diagnosis of relevant habitats and populations. It is also clear that assemblages change over time, and there can be considerable ecological lags before outcomes are measurable (MacNally, 2008; Verdonschot, *et al.,* 2013; Watts *et al.,* 2020).

2a: Implement

The guidance for this step should be read in conjunction with CIEEM's Project Planning and Implementation Overarching Topic. This drives the appropriate action, engagement and collaboration across appropriate scales to meet the needs of large-scale delivery.

There have been several studies into what can be learnt from different initiatives, and a number of ways of categorising the approaches taken. **Box 2** provides a summary breakdown for large-scale nature recovery initiatives. While further detail is found within the Project Planning and Implementation overarching topic, large-scale initiatives have some critical factors upon which successful implementation is dependent:

- Shared vision and common purpose, including clear goals (Black, Groombridge and Jones, 2011)
- Appropriate and fit-for-purpose governance and decision-making (Margerum, 2011)
- Leadership (Black, 2021; Englefield *et al*., 2019)
- Collaboration and partnership, including engagement and dialogue with communities (Margerum, 2011)
- Sound understanding of potential barriers to success, planned for during the project diagnosis and creation (Hanson *et al.,* 2015; Endangered Landscape and Seascapes Programme, 2024)

Box 2

Common Types of Large-Scale Nature Recovery Initiatives (based on Adams (2012), Adams *et al*. (2016), Boulton *et al.* (2013), Eigenbrod (2016) and Macgregor *et al.* (2012)).

Land Ownership

- *Single large landowner* e.g. estate, National Trust
- *Clusters* e.g. numerous small or collaboration of a number of large landowners
- *Conservation Zones and Target Areas* e.g. Countryside Stewardship and land management schemes targeted specifically at biodiversity
- *Other schemes based around wider environmental improvements* e.g. Marine Protection Zones, Catchment Sensitive Farming or sustainable farming approaches

Conservation Collaboration and Partnerships

- *Coordinated initiatives* e.g. achieving joint outcomes but with individual actions and without direct collaboration
- *Collaborative partnership initiatives* e.g. joint action and outcomes with levels of governance to lead decision-making and partnership delivery such as Landscape Recovery initiatives

Statutory Management Landscapes and Seascapes

- *Commons and Forest Statutory Conservators created by Parliamentary Statute* e.g. Epping Forest and Malvern Hills Conservators
- *National Government Sponsored Landscapes or Seascapes* e.g. National Forest or Highly Protected Marine Areas

2b: Monitor

Monitoring is crucial as part of adaptive management and to ensure successful outcomes. Further details are available within CIEEM's Monitoring Overarching Topic. The scarcity of studies examining large-scale outcomes has motivated the Endangered Landscape and Seascape Programme to focus on filling this evidence gap and define its own monitoring framework (Endangered Landscapes and Seascapes Programme 2024). It requires the gathering of data and evidence through standard methods and protocols, matched appropriately to the scheme or initiative's goals.

3a Evaluate

The systematic assessment of design, implementation and outcomes of an initiative (or any action aiming to deliver change) is defined as evaluation (see HM Treasury Magenta Book). In large-scale nature recovery initiatives this process will determine progress and understand the level of impact as well as the reasons for any results. Data gathered or

generated through monitoring should be assessed and analysed to decide what weight to give information, so that decision-making can be informed and clearly communicate any trajectories towards success and achievement of goals. For more detailed guidance see CIEEM's Monitoring Overarching Topic.

As a critical step in adaptive management, and as part of the provision of wider evidence to practitioners, this is an important part of international standards for restoration (Gann *et al.*, 2019) and the sharing of lessons learnt (Principle 9 of CIEEM's Good Practice Guidance for Ecological Restoration).

3b Adapt

Dealing with change is a necessary part of large-scale delivery. The scale and pace of action that will be required at scale will require any approach to adjust, based on earlier assumptions and new learning. Our approaches will need to embrace or restore dynamic ecosystems, make the best use of networks of practice, and plan for future conditions. Examples of this could be new invasive non-native species, examining the value of novel ecosystems, the impact of diseases (e.g. Ash Dieback *Hymenoscyphus fraxineus* or Chytrid *Batrachochytrium dendrobatidis*), or the ecosystem-level impacts of nutrient enrichment and deposition).

The Adaptive Management approach is a useful tool that enables a re-examination of diagnosis, planning and related assumptions so that change can be incorporated. The time-scale of recovery will require considerable adaptation; trajectories, goals and measures should be reassessed so that planning can be updated within the cyclical nature of adaptive management. Adaptive management also enables large-scale initiatives to change and evolve towards future conditions. The climate crisis is the most pressing of the drivers of these future conditions.

Adapting to become Climate Smart

There is already evidence that climate change is affecting biodiversity across the UK and Ireland, with changes to seasons, hydrological regimes and rainfall, and extreme weather (Natural England and RSPB, 2019). Impacts will continue and will be most significant for the more vulnerable ecosystems or species (such as rivers and wetlands or coastal systems), resulting in a bottleneck of species adaptation or envelope extinction as a result of the loss of conditions necessary for survival. It is now suggested that protected site mechanisms should focus on the viability of regional species populations and the capacity of these sites to sustain adequate samples of populations in the face of environmental change (Gardner *et al.,* 2023). One implication for this focus would be to further increase the importance of action outside protected sites, and with a more systematic and ecological network approach.

The expected scale and severity of impact resulting from the climate crisis has also meant that nature recovery needs to deal with future unknown conditions. Ecological communities are likely to shift unpredictably in terms of geography and constituents (species will flourish, wither or invade), with new analogue ecosystems likely and a need to focus on an intrinsic resilience of species and places (Folke *et al.,* 2010; Moore and Schindler, 2022). Success (defined by system resilience and species persistence) will be more likely through a focus on the natural processes that create ecosystem heterogeneity, but not necessarily the same species in the same space. This will all require forward-looking planning at large scale (Keeley *et al.,* 2018). New approaches to decision-making when dealing with change are required, and increasingly ecosystem restorers and managers are using the Resist-Accept-Direct model to support them (for further details see the United States Geological Survey The Resist-Accept-Direct (RAD) Framework and BES's Embracing uncertainty in applied ecology).

In planning adaptation for large-scale nature recovery, key guidance can be summarised as follows:

- ☐ Aim for building in resilience and preparing for inevitable change.
- ☐ Adaptation should aim to incorporate the wider benefits from ecosystems.
- ☐ It is more than a 'one problem fix' so that impacts are not displaced – systems-thinking should be deployed.
- ☐ Focus on large-scale heterogeneity and options at local to regional scales, away from specific prescriptive approaches.

- Any consideration of likely scenarios will need to utilise several pathways and identify both immediate needs as well as a path for longer-term change requirements.

For further details and guidance please see CIEEM's Integrating Ecosystem Services Overarching Topic.

Funding and Costs

The growing importance, relevance and interest in nature recovery has meant that the costs for implementation are increasingly being estimated. Funding gaps for the UK delivery over ten years have been estimated at £56 billion (GFI, eftec & Rayment Consulting 2021), and the Republic of Ireland is currently developing estimates of the costs using the international BIOFIN model.

A more specific breakdown from 2019 (Rayment, 2019) looking at the cost of delivering biodiversity priorities across the UK, together with information being developed in the Republic of Ireland (Bullock, C. *Pers. Comm*.) provides a good guide to total costs required annually.

- England £1,674 million
- Scotland £729 million
- Republic of Ireland €343 to €432 million
- Wales £273 million
- Northern Ireland £188 million

Increasing private financial investment in restoration is a priority across all nations (see HM Government (2023) for UK; Ball *et al.* (2023) for Ireland), and an important goal defined by the Global Biodiversity Framework. In parallel, an increase in standards and assurance is required, not only for restoration activities (such as that provided by CIEEM's Rebuilding Nature guidance series), but also for more specific initiatives such as Saving Scotland's Rainforest with Natural Capital Investment being developed by the Alliance for Scotland's Rainforests, or the Natural Asset recovery tool for Credit Nature (ecosulis 2019). See also Future Economy Scotland's useful briefing note Can private finance fix Scotland's nature crisis?

Summary of Key Points

A much faster pace and larger scale of ecological restoration is needed to achieve national and international goals and targets, including achieving full nature recovery.

The important goal is to restore natural processes and dynamics, creating self-sustaining, robust ecosystems that are resilient to external threats and pressures. Our approaches need to embrace or restore dynamic ecosystems, make the best use of networks of practice, and plan for future conditions.

Any work on nature recovery and restoration requires an understanding of what has been driving decline and degradation. A critical part of planning large-scale restoration and recovery is understanding the components of ecological networks, such as core areas, restoration areas, corridors, connectivity and buffer areas.

The nature of large-scale restoration and recovery makes adaptive management and ensuing monitoring and evaluation a critical part to achieve successful outcomes.

- Aim for building in resilience and preparing for inevitable change
- Aim to incorporate the wider benefits from ecosystems
- Systems-thinking is required and no scheme or initiative should act in a silo

- ☐ Collaboration and dialogue is an increasingly critical element as scale increases
- ☐ Focus on greater scales of heterogeneity and move away from prescriptive approaches

Table 3

Key supplementary definitions relevant to nature recovery.

Term	Definition	Reference
Recovery and Large Scale		
Ecosystem Recovery	The process by which an ecosystem returns to a previous condition after being in a degraded or disrupted condition.	(Elliott *et al.*, 2007)
	An ecosystem has recovered when it contains sufficient biotic and abiotic resources to continue its development without further assistance or subsidy. It will sustain itself structurally and functionally.	(Society for Ecological Restoration International Science & Policy Working Group, 2004)
	A pathway of ecosystem redevelopment towards a less compromised state, or the attainment of a fully functioning system comparable to target reference sites.	(Simenstad *et al.*, 2006)
	The outcome sought or achieved as a result of the process / activity of ecological restoration.	(Gann *et al.*, 2019)
Landscape Restoration	Landscape restoration can be defined as a planned process that seeks to recover landscape-level ecological integrity and the capacity of a landscape to provide long-term, landscape-specific ecosystem services essential for improving environmental quality and human wellbeing.	(Gann *et al.*, 2019)
	Landscape restoration refers to restoration of biodiversity and natural processes within degraded lands and seas on a scale that may vary from a few square kilometres to ecological corridors that traverse continents.	(Ockendon *et al.*, 2018)
Other Effective area-Based Conservation Measures (OECMs)	A geographically defined area other than a Protected Area, which is governed and managed in ways that achieve positive and sustained long-term outcomes for the *in situ* conservation of biodiversity, with associated ecosystem functions and services and, where applicable, cultural, spiritual, socioeconomic, and other locally relevant values.	(MacKinnon, 2019) and the IUCN on OECMs
Large-scale	A focus on conserving biodiversity at the landscape / seascape, ecosystem or regional scale. Difficult to define but usually over 500 ha, and increasingly over 10,000 ha.	See **Box 1** for further detail
Resilience	The ability of an ecosystem to maintain its capacity for renewal in a dynamic environment, and ultimately the capacity to recover once a loss or impact has occurred.	(Gunderson, 2000; Lake, 2013)
Resistance	The ability to cope with disturbance without loss or negative impact.	
Sensitivity	A measure of the risks and requirements of recovery for a species population, habitat or ecosystem based on the interaction of resilience and resistance.	
Complexity	The number of components in an ecological system and the number of connections amongst them, along with associated emergent properties.	

Reference Ecosystem	A 'reference ecosystem' can be an actual site (reference site) or a conceptual reference ecosystem model synthesised from numerous reference sites, field indicators and historical and predictive records. Note that the terms Reference Ecosystem, Reference Site, Reference State or Reference Model are often used in literature.	(Gann *et al.*, 2019)
Species Adaptation Bottleneck	Populations can become bottlenecked because of an impact (e.g. from habitat loss) that drives a drastic decrease in population numbers. This can result in a loss of genetic diversity and limit a species' ability to adapt to environmental change. It is receiving increasing attention because of the climate crisis.	
Envelope Extinction	A climate envelope represents the conditions under which a species is successful in persisting over time; as climate change impacts these conditions and they change, the species may not be able to adapt to persist under shifting conditions and eventually becomes extinct as a result of the climate envelope no longer existing.	(Thomas *et al.*, 2004)
Ecosystem Processes	The flows of energy and matter that occur within an ecosystem. They are dependent on the interactions between biotic and abiotic components, and include: energy flow; nutrient cycling; community dynamics; and evolutionary processes. Some definitions include core and beneficial processes to more easily identify those more directly generating ecosystem services.	(Balmford *et al.*, 2008)
Landscape, Seascape and Networks		
Landscape	'Landscape' means an area, as perceived by people, whose character is the result of the action and interaction of natural and / or human factors.	European Landscape Convention, Chapter I, Article 1
Seascape	Spatially heterogeneous and dynamic [marine] spaces that can be delineated at a wide range of scales in time and space. Large, multiple-use marine areas, defined scientifically and strategically, in which government authorities, private organizations, and other stakeholders cooperate to conserve the diversity and abundance of marine life and promote human wellbeing.	(Pittman, 2018) (Murphy *et al.*, 2021)
Wholescape	This approach seeks to integrate different ways of working, institutions, governance and environmental agendas with the need to work at larger spatial scales, combining landscapes, coastal zones and seascapes.	((Maltby *et al.*, 2019)
Ecological Network	An ecological network can be understood as a number of core, well connected, high quality areas of well functioning ecosystems, together with those parts of the intervening landscape that are 'wildlife-friendly' and which, collectively, allow wildlife to thrive. A hierarchy of priority actions are linked to nature recovery: (a) improve core wildlife sites; (b) increase the size of core sites; (c) increase the number of core sites; (d) improve the 'permeability' of the surrounding landscape for the movement of wildlife; and (e) create corridors of connecting habitat. In addition there is a need to develop a number of Large Nature Areas (c. 5-12,000 ha) within a country that will provide centres from which wildlife will brim over into the countryside.	((Crick *et al.*, 2020b)

Nature Network	As well as having a primary role of supporting abundant wildlife, a nature network should also enhance natural beauty and heritage, and conserve geodiversity. Opportunities should be taken to deliver benefits for people, such as flood alleviation, recreational opportunities and to provide nature-based solutions to climate change adaptation and mitigation.	Adapted from Crick *et al.* (2020b)
Core Areas	Critical areas holding viable populations and optimal habitats where the primary land use objective is nature conservation.	Adapted from Bennett & Mulongoy, (2006) and Hilty *et al.* (2020)
Restoration areas	Restoring degraded ecosystems where appropriate, to achieve long term expansion of core areas and corridors.	
Buffering and Sustainable Use	Buffering critical areas from the effects of potentially damaging external activities and promoting the sustainable use of natural resources in areas of importance to biodiversity conservation.	
Connectivity	The level of ecological coherence in an area and how it influences species behaviour (e.g. impeding or improving movement). Primarily used to measure or describe how an environment or landscape links populations and habitats through species movement and dispersal. Corridors are increasingly being used to strengthen connectivity; these can be physically connected (direct actual connection) or functionally connected (no physical connection but an environment may still allow movement of a species).	
Patch	A distinct and relatively uniform area of habitat separated from other such areas by unsuitable habitat.	
Matrix	The wider and surrounding land or sea use in an area that species have to move and disperse through. The number, size and configuration of habitat patches as well as the nature of the matrix will determine the hostility of the environment.	
Mosaic	Multiple physically connected habitats with different structures and complexity.	
Focal Species and Assembly Rules		
Focal Species	A species that is the focus of conservation efforts, usually because of its sensitivity, extinction risk, or increasingly its role in ecosystem function.	
Foundational Species	Spatially dominant, habitat-defining organisms.	(Ellison, 2019; Heineke *et al.*, 2023)
Keystone Species	Species with an important role in the integrity of the ecosystem structure and functioning, first applied in relation to top-down control by predators.	(Hale & Koprowski, 2018; Simberloff, 1998)
Umbrella Species	A species targeted for conservation action, because the same action will conserve co-occurring species and / or act as a wider surrogate for biodiversity conservation in a relevant ecosystem.	(Roberge & Angelstam, 2004)
Flagship Species	A species used as an engagement, communication and / or cultural tool to exemplify action, usually with a wide network of associations in relevant sectors or with the public.	(Jepson & Barua, 2015)
Charismatic Species	In a far more human-led approach, a species which is chosen because of its appeal to society and more specifically because of fundraising potential.	(Albert *et al.*, 2018)

Ecosystem Engineer	An organism that can create, maintain, and transform habitats. They usually modulate ecosystem resource flows, and enable better functioning and greater success in restoration.	(Johnson *et al*., 2020)
Historical Contingency	The impact that the order and timing of past events can have on community assembly.	(Fukami, 2015)
Priority Effects	The inhibitory or facultative effects that influence species, populations and trophic structure, from those species arriving early or first.	(JNCC *et al.,* 2022)

Biography

Tim Graham

Tim Graham MCIEEM is Associate Director at RSK Wilding where he co-founded the Responsible Body business unit, leading the function as well as wider restoration and nature recovery work. Previously he worked for a short time at the Office for Environmental Protection as it was set up and was CEO of two Wildlife Trusts. He has a background in large-scale restoration, has been involved in ecological restoration for 25 years, and is now board member for the SER Large Scale Ecological Restoration Section.

Publication of this guidance is kindly supported by RSK Wilding

RSK Wilding was established in 2020 by a group of ecologists and environmental specialists who believe in the power of nature restoration and specifically, its ability to provide numerous other benefits: carbon sequestration, flood risk mitigation, the improvement of water quality or enhanced access to nature.

As part of RSK Biocensus and also the wider RSK Group, we have access to an enormous number of environmental, agricultural, natural capital, communications and green finance experts. Whatever your nature restoration needs, we have experienced specialists who can help.

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