Land Use Decision Research & Guidance

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Report For

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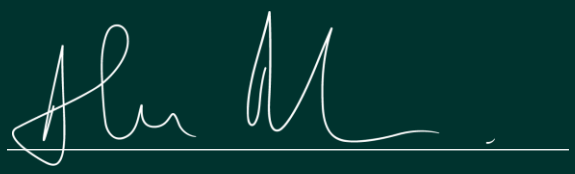

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1.0 Introduction

1.1 Who this guidance is for

This guidance document aims to support groups, organisations and partnerships carrying out landscape restoration projects. In particular, this guidance was commissioned by the Environment Agency to support six new pilot study areas under the Nature-based Solutions (NbS) for Climate Change at the Landscape Scale Fund. Spread across England, these pilots are:

1. Wild Exmoor Carbon Sequestration Project;
2. Plymouth's Natural Grid;
3. Wansbeck Restoration for Climate Change;
4. Oxfordshire-Buckinghamshire Freshwater Network;
5. Severn Solutions for Nature's Recovery;
6. Derwent Forest Landscape Recovery Project.

While this guidance was shaped through discussion with each of the six pilots, the information provided is relevant to other landscape restoration projects aiming to deliver NbS for climate and nature recovery.

1.2 How this guidance can help you

During a landscape restoration project, different decisions and actions take place, from planning and scoping the project, to delivery and maintenance. Such decision-making can be approached in multiple ways and with the support of various tools, including software, databases, applications and frameworks.

This guidance document provides a summary of the key decision-making stages expected to be made during a landscape restoration project and a selection of suggested tools available to support those decisions. Although every landscape restoration project will have unique circumstances, such as, habitat type, geographic location and scale, there are common decision-making steps for which particular types of tools are relevant.

This guidance contains a shortlist of 15 tools. The shortlist was developed through a literature review and interviews with the six pilot projects in order to capture the most useful and functional tools for landscape restoration projects. For each tool the following information is provided:

- a description of the tool, including type, purpose and habitat coverage;
- the advantages and disadvantages of the tool, based on the literature review and feedback from the six pilot projects;
- the decision-making stage(s) for which the tool is most relevant; and
- whether the tool is paid for or free and open access.

In addition to the shortlist of tools, this guidance also contains a table of additional suggested resources and guidance documents, which includes GIS tools required to run some of the shortlisted tools, two directories of tools, and a number of other resources beneficial for wider context and assessment in landscape projects. A long list of available tools is provided in the Appendix.

1.2.1 How to use this document

This document is organised as follows:

- **Section 2.0** provides an overview of the key decision-making stages in landscape restoration projects;
- **Section 3.0** presents the shortlist of 15 tools and accompanying details in a table;
- **Section 4.0** provides other additional useful resources; and
- **The Appendix** includes a long list of tools and resources and background information on the production of this guidance.

2.0 Decision Making Stages in Landscape Restoration Projects

There is a wealth of guidance available on how to develop and deliver landscape and habitat restoration projects. While the detail of different resources may vary, there are three common, broad stages in landscape restoration projects: planning/design, implementation and maintenance (for more information see Appendix A 2.0).[1]

Specific decisions and actions will take place at each stage, as well as activities which continue throughout the duration of a project, such as stakeholder engagement and data collection.

This guidance focuses on the design and implementation of landscape restoration projects. As summarised in Figure 1, when designing a project the following key decisions are needed:

1. **What main problem(s) you are seeking to address** i.e. why are you changing the land use. It is important to understand the condition of a current or pre-existing ecosystem in a landscape and the key environmental challenges which the landscape faces. This helps determine the most appropriate restoration technique, ensuring interventions are targeted and relevant, either within a local context or aligned with national priorities (e.g., the 25 Year Environment Plan goals). Setting out the purpose of the project can help secure funding, enables clear communication with stakeholders and allows outcomes to be monitored against project targets.[2]
2. **What you are planning to do** i.e. what land use change are you planning. Following the project purpose and targets, it is important to set out the project focus through goals and specific objectives. These should be informed by site assessments and baseline data collection.[3] The planned interventions should deliver the desired ecological and social benefits within the location context. Measurable indicators should be identified in order to monitor progress.
3. **Where you are planning to make the land use change.** To be successful, it is crucial that appropriate sites for habitat restoration are selected, with attention to logistical and social, as well as ecological factors.
4. **Who you are working with**. Identifying partners and stakeholders is key to a successful landscape restoration project and is relevant throughout the development and delivery of a project. Effective stakeholder engagement can reduce conflict, increase access to knowledge and support and help ensure long term viability of a project by increasing community buy-in and ownership.[4]

   Different stakeholders will be engaged in different ways during a project, but key stakeholders are likely to include: [5]

   i. Businesses and companies (the private sector), as beneficiaries, investors or as an industry impacted by the restoration;

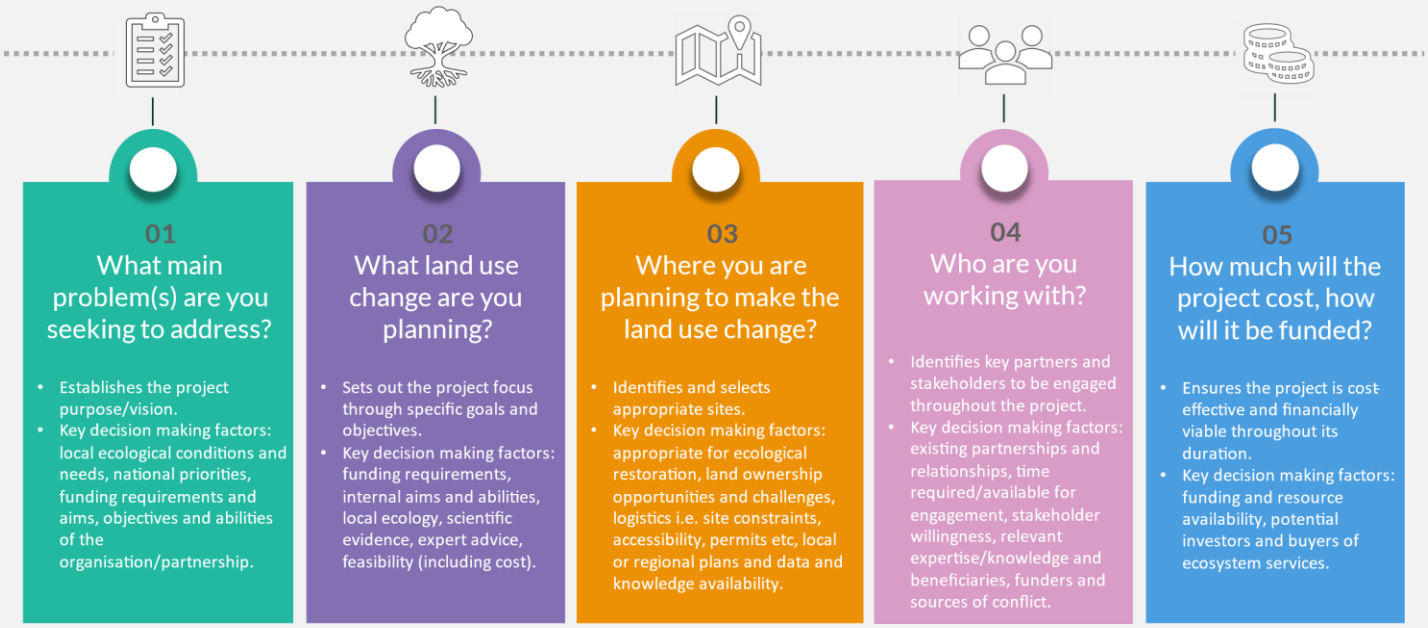
   ii. Local communities, as those most likely to be directly impacted by a project, but also as potential beneficiaries and volunteers;

   iii. Local, regional and national bodies and authorities, as regulators, beneficiaries or potential providers of ecosystem services. Some interventions will have specific permitting and licensing requirements for which the relevant authority would need to be consulted;

   iv. Private landowners, as potential providers of land for habitat restoration;

[1] Marxan (2022) A framework for systematic conservation planning. Available at https://marxansolutions.org/a-framework-for-systematic-conservation-planning/
[2] Gamble C., Debney, A., Glover, A., Bertelli, C., Green, B., Hendy, I., Lilley, R., Nuuttila, H., Potouroglou, M., Ragazzola, F., Unsworth, R. and Preston, J, (eds) (2021). Seagrass Restoration Handbook. Zoological Society of London, UK., London, UK.
[3] Gann, G.D., McDonald, T., Walder, B., Aronson, J., Nelson, C.R., Jonson, J., Hallett, J.G., Eisenberg, C., Guariguata, M.R., Liu, J., Hua, F., Echeverría, C., Gonzales, E., Shaw, N., Decleer, K. and Dixon, K.W. (2019), International principles and standards for the practice of ecological restoration. Second edition. Restor Ecol, 27: S1-S46. https://doi.org/10.1111/rec.13035
[4] Willemen, L., R. Kozar, A. Desalegn, and L.E. Buck. 2014. Spatial Planning and Monitoring of Landscape Interventions: Maps to Link People with their Landscapes: A User's Guide. Washington, DC: EcoAgriculture Partners.
[5] Brill, Gregg, Deborah Carlin, Shannon McNeeley, Delilah Griswold (2022). Stakeholder Engagement Guide for Nature-Based Solutions. United Nations CEO Water Mandate and Pacific Institute. Oakland, California. www.ceowatermandate.org/nbs/engagementguide

Figure 1 Overview of the key decision-making stages discussed in this guide



v. NGOs and community organisations, typically as project delivery support e.g. volunteers or expert advisors; and

vi. Other investors and donors, including public sector grants and philanthropy.

5. **How much will the project cost and how will it be funded**. Landscape restoration projects can take place over several years, meaning a variety of funders and types of funding may be required throughout the project. Understanding how much a project will cost, putting together a strong business case/financial plan and identifying potential buyers/investors will help secure funding.

There are numerous tools available to support each of these key decisions. Interviews with representatives from the six landscape restoration projects piloting NbS provided valuable insight into how they made these decisions in reality, the tools they used and other important factors which supported their decision making. This stakeholder engagement highlighted the following key points:

- Although tools are used to support decision making, there are many other decision-making factors that dominate key aspects of project design;
- Tools were most commonly used to support decisions around **where** to change land use in landscape restoration projects;
- There was a strong preference to use tools that are already available, accessible (either open or at low cost) and familiar to the project team; and
- There are many available tools which are not commonly used.

Table 1 below sets out each of the five key decision-making points previously listed. The importance of each point is highlighted through a description of the desired outcome – or optimal design – for that decision. The overview summarises the use of tools to support the decision, other key factors and gaps or limitations reported by the pilots. The tools currently used by the six pilot projects are listed for each key decision, as are important decision-making factors. The final column in the table contains suggested tools that could support each decision point, with some tools relevant for more than one decision. These tools, and the criteria on which they were selected, are discussed in more detail in section 3.0 of this guidance.

It is important to note that this table does not represent a linear process. Decision making is likely to be iterative and may involve returning to previous stages throughout the project development and implementation.

Table 1 Key decisions in planning landscape restoration projects- desired outcomes, support tools and important decision-making factors

Decision/ design element	Desired outcome	Overview	Tools used by the six pilot projects to support decision making	Key decision-making factors	Suggested tools to support decision making
1. What main problems are you seeking to address? (i.e. why are you changing the land use)	Project is designed to address priority challenges in the local geography whilst maximising other ecosystem benefits and social gains. Key stakeholders are identified and engaged with, in particular, the local community and expert consultation (see decision four).	Limited use of tools at this stage, beyond using maps (GIS) to understand current land use and habitat types in the desired project location. Decision making primarily based on other factors, including opportunistic response to funding, internal aims and abilities and local environmental needs. Problems which the six pilots are seeking to address include: climate change, nature poor agricultural land, habitat resilience, restoration and creation, habitat fragmentation and biodiversity loss.	ArcGIS and qGIS- used for habitat and land use mapping.	• **Opportunistic response to requirements of available funding:** projects are typically shaped, or reshaped, to reflect the requirements of specific funding streams and grants as they emerge. • **Longer-term agenda driven aims, objectives and abilities:** a project is often designed by an organisation or a partnership to align with their goals or overarching mission, to complement and extend current work or use skills that the team have. For instance, an organisation may have broad aims to address climate change, improve biodiversity or deliver against certain targets/principles. • **Local geography:** the local environment in which the project will take place may present specific environmental challenges or opportunities which the interventions seek to address, such as fragmented habitat, degraded riparian landscapes, nature poor agricultural land or Sites of Special Scientific Interest (SSSI). A project may also be influenced by existing priorities for an area, such as Local Nature Recovery Strategies.	• Biodiversity Metric 4.0 • Catchment Based Approach Data Package (CaBA) • Cool Farm Tool • Circuitscape • Decision Support for Land Use Change for Environmental Benefit • Integrated Valuation of Ecosystem Services and Trade-offs (InVEST) • Natural Capital Evidence Handbook • Natural Environment Evaluation Tool (NEVO)

Decision/ design element	Desired outcome	Overview	Tools used by the six pilot projects to support decision making	Key decision-making factors	Suggested tools to support decision making
2. What are you planning to do? (i.e. what land use change are you planning)	The intervention is feasible (i.e. it will deliver desired outcomes within resource constraints and regulatory context), resilient and will maximise environmental and social benefits while minimising unintended consequences. Outcomes can be measured and monitored. Local and scientific knowledge is drawn on through engagement with the community and expert consultation.	Together with decision point three, this is where most organisations and partnerships use tools to support decision making. In particular, baseline data collection, whether for habitat type/condition or for species, is often key for understanding current conditions and for future impact monitoring. The ability to add layers of information onto GIS maps and to increase the resolution of spatial data was felt to be important by a number of the pilots. Sometimes bespoke tools, adapted to a specific organisation are needed. For instance, a bespoke GIS system adapted to the way an organisation manages its landholdings. The following limitations/gaps were reported:	• Species surveys and Phase 1 habitat survey datasets- baseline data collection and monitoring. • ArcGIS, qGIS, UKHab and statistical modelling software- for habitat mapping (historic and current), opportunity mapping, trajectory maps, mapping natural capital and ecosystem service provision. Relevant data layers include existing habitat, priority habitat, species types and occurrence and landscape types/land use. • ArcGIS collector app- for collecting and updating data on-site. • Ortho mapping through ArcGIS e.g. generating an image mosaic, digital terrain model (DTM) or digital surface model (DSM) from remote sensing images. • Bespoke internal GIS tools, for example which identify the habitat to be created at a high resolution (e.g. number of trees to be planted). • Fixed point photography and drone footage- high	**In addition to funding requirements, internal aims and abilities and local geographical/environmental specificities, the following factors can influence what interventions are delivered:** • **Scientific evidence and expert advice:** some organisations or partnerships may seek technical guidance about specific interventions e.g. using a geomorphologist to identify areas where river restoration would enhance riparian habitat or using an environmental consultant to understand countryside stewardship. This expertise may from within the organisation/ partnership or external (i.e. consultants). External consultants may use or develop their own software, mapping or modelling methods to identify interventions. Local Environmental Records Centres (LERCs) are also sources of expertise and data, such as historic species records and habitat maps. • **Citizen science:** an organisation or partnership may collect and classify data through public volunteers. • **Cost estimates:** the type and scope of interventions, as well as tools used, will be determined to some degree by available budget. Project	• ADvancing Analysis of Natural Capital in LandscapE DecisionS (ADVANCES) • Benefits Estimation Tool (B£ST) • Biodiversity Metric 4.0 • CaBA • Cool Farm Tool • Competition for Resources between Agent Functional Types (CRAFTY) • Marxan • Managing Ecosystem Services Evidence Review (MESER)

Decision/ design element	Desired outcome	Overview	Tools used by the six pilot projects to support decision making	Key decision-making factors	Suggested tools to support decision making
		• There is a need for more tailored advice around sites and constraints in protected landscapes e.g. national parks. • Local Environmental Records Centres data can have gaps and may not be up-to-date. • Apps used in the field rely on a good internet connection which may not always be available.	resolution imagery used to capture current habitat condition, to create detailed project designs and cross sections and to monitor change over time. • Open access national LiDAR data- for detailed mapping of landforms for site design. • TUFLOW- used to improve flood risk reduction modelling. • Catchment Based Approach (CaBA) explorer map online portal- used for flood risk mapping. • Cartographer- used for river condition assessment. • AutoCAD- used to provide quantitative information for the tender e.g. site specific design.	costs are typically estimated at the early planning/design stage, such as when applying for funding.	
3. Where are you planning to make the land use change?	Interventions are delivered in targeted locations to achieve most effective environmental and social impact. Unintended consequences are	Together with decision point two (what land use change are you planning), this is where most organisations and partnerships use tools to support decision making. Mapping tools are particularly useful for identifying where	• ArcGIS, qGIS, UKHab surveys and statistical modelling software- used for habitat mapping (historic and current), opportunity mapping and trajectory maps. • Defra MAGIC maps- used to identify landscape	• **Existing land ownership, stakeholder engagement and opportunism:** where interventions are located depends to a significant degree on what land is owned by the organisation or partners. If the organisation or partners do not own the desired land, the location is often then determined by engagement with individual landowners/managers or groups of landowners such as farmer clusters.	The tools suggested below for determining where to make land use changes have some overlap with decision 1 (what problems are you seeking to address),

Decision/ design element	Desired outcome	Overview	Tools used by the six pilot projects to support decision making	Key decision-making factors	Suggested tools to support decision making
	avoided and potential risks/ vulnerabilities are accounted for. Local and expert knowledge is drawn on through community engagement and expert consultation. Other key stakeholders at this point include private and public landowners and relevant local, regional or national authorities and regulators (i.e. for permits or licensing).	interventions would be most effective. Tools which provide high resolution, layered data are especially valuable. Similarly to decision point two, some technical processes and tool development may be outsourced to ecological consultancies or conducted by partners such as local/county councils. The following limitations/gaps were reported: • Lack of awareness and training for ArcGIS, qGIS and MAGIC limits potential use. • License restrictions for GIS and OS data. • Low resolution of some LiDAR data. • Limited and costly access to data about neighbouring land parcels owned by others.	designations, constraints and consent requirements. • HabiMap citizen science surveys (a Gloucestershire county-wide exercise based on UKHab)- used to assess current habitat condition and map habitats for baseline data collection and to understand potential habitat connectivity. • Species surveys- used for baseline data collection and monitoring. • Other tools used by partners or consultancies: • R or Python- used for least cost ecological modelling to create nature recovery network maps. The network maps are used to show where habitats could be connected, overlayed with flood risk reduction and water quality improvements data. • GIS- used to map natural capital and ecosystem provision. • Natural flood management modelling.	This is likely to involve leveraging existing relationships. • **Existing site constraints, accessibility and potential land use conflicts:** interventions on some sites may require permissions, permits or planning consents. The complexity and difficulty of obtaining such permissions, as well as the time it takes, may dictate where interventions are located. Additionally, certain locations such as SSSIs, special areas of conservation (SACs), national parks and areas of outstanding natural beauty (ANOBs) are protected and have development restrictions. Sites may be excluded if a change in land use conflicts with current/future use or if it is physically inaccessible by the delivery team. • **Local plans and strategies:** pre-existing local or national schemes and policies which map valuable or priority areas, such as Local Nature Recovery Strategies may shape where interventions are located. • **Data availability and existing knowledge:** an organisation or partnership may choose certain sites based on the data and knowledge they already have, or can obtain, about those locations. • **Best environmental impact:** internal knowledge or external expert advice	because these tools serve multiple purposes. • Biodiversity Metric 4.0 • CaBA • CRAFTY • Circuitscape • Land App • Marxan • MESER

Decision/ design element	Desired outcome	Overview	Tools used by the six pilot projects to support decision making	Key decision-making factors	Suggested tools to support decision making
				will typically be used to identify where certain interventions are feasible and desired outcomes will be achieved.	
4. Who are you working with? (i.e. who are your key partners and stakeholders)	A diverse range of stakeholders are first identified, then engaged in the project including: NGOs, landowners, businesses, community groups, local authorities and government bodies. Stakeholder needs are met, trade-offs/conflicts are negotiated and buy-in for the project increases. Engagement is equitable and inclusive and continues throughout the project, building trust and commitment.	Most of the pilots recognised the importance of stakeholder engagement, particularly at the planning stage of a project. However, no engagement tools were reported.	No tools reported by the pilots.	• **Existing partnerships and relationships:** organisations and partnerships will typically leverage their existing network and relationships. • **Grant application deadlines and project timelines:** bidding and project delivery deadlines may constrain the amount of stakeholder engagement possible. • **Willingness of stakeholders:** the receptiveness and interest of landowners in particular will impact the extent to which they are involved in the project. • **Relevant expertise:** the type of intervention and location will likely affect which stakeholders are involved. For instance, restoration of specific habitats like heathland, woodland or saltmarshes may require specialists such as from Natural England or the Forestry Commission. Sites located in national parks will mean working with the national park authority while interventions on farmland may involve farming specialists.	• CaBA • Land App • Spatial Planning and Monitoring of Landscape Intervention

Decision/ design element	Desired outcome	Overview	Tools used by the six pilot projects to support decision making	Key decision-making factors	Suggested tools to support decision making
5. How much will the project cost and how will it be funded?	The project has a financial model and strong business case which optimises environmental and social outcomes while ensuring cost-effectiveness.[6] The project receives enough funding to cover all proposed interventions and activities. Potential funders, buyers and investors are identified and engaged with.	The following limitations/gaps were reported: • limited knowledge regarding payments for ecosystem services, in particular: understanding what ecosystem services they have, the potential markets, how to prioritise services and buyers and how to generate a business plan including income generation for farmers.	• Financial models built in Excel spreadsheets. • Developed own guidance for landowners- a woodland creation toolkit and natural flood management toolkit- explaining how to do woodland creation/natural flood management and what funding is available.	• **Projects costed to match the funding available:** public and government grants generally specify how much money can be applied for. Projects are typically budgeted to reflect the requirements of specific funding streams and grants. Some grants require match funding. • **Own resources:** some organisations or partnerships may already have funding, revenue or members of staff available for a new project. • **Ecosystem service provision:** if an organisation or partnership is aiming to attract private investment, the buyers (beneficiaries) depend on the type of ecosystem service being sold, for instance, water companies may be specifically interested in projects which reduce flood risk or increase water quality, such as natural flood management.	• Decision Support for Land Use Change for Environmental Benefit • Land App • Marxan

[6] Albert, C., Brillinger, M., Guerrero, P. *et al.* Planning nature-based solutions: Principles, steps, and insights. *Ambio* **50**, 1446–1461 (2021). https://doi.org/10.1007/s13280-020-01365-1

3.0 Tools and Resources for Landscape Restoration Projects

3.1 What are decision support tools?

Decision support tools are any guides, techniques, methods or approaches that can be used to aid decision making. Tools can range in complexity, from basic flowcharts to computer modelling and are typically tailored for particular contexts and purposes.

Tools can support decision making in a number of ways, such as enabling assessment, mapping specific interventions, modelling scenarios based on specific data and assumptions and highlighting trade-offs and synergies of particular actions.[7]

In the context of landscape restoration projects, tools can not only be used to support decisions about ecological and economic elements of a project, but also to guide stakeholder engagement processes.

3.2 Decision Support Tools Shortlist

This section provides a shortlist of 15 decision support tools which can be used in landscape restoration projects.

The shortlist of tools presented here was developed through a literature review which examined the key decision-making stages in landscape restoration projects and the tools available to support those decisions. Interviews with the six pilot projects under the NbS for Climate Change funding scheme then provided insight into which tools have been most commonly used by these projects in practice, why the project teams used these tools and their perceived pros and cons. These stakeholder interviews highlighted that:

- Several tools often perform similar functions;
- Deciding which tool to use often depends on the level of expertise of the user, familiarity with the tool and the ease of use;
- Cost, licensing limitations and shareability are also key considerations when deciding what tool to use in a project.

Based on this insight, several criteria were developed in order to build a shortlist of tools for this guidance. The criteria, and how they were applied, can be viewed in Appendix A 3.0, but included ease of use, cost, wider applicability and the types of outputs provided by the tool.

The resulting shortlist of 15 tools is summarised in Table 2 below, followed by a detailed description in Table 3. Table 2 also provides hyperlinks to each tool and the page number for where more detail can be found.

For each tool, the following information is provided in Table 3:

1. **Name of tool**
2. **Type of tool:** i.e. software, guidance, database etc.
3. **Description and purpose:** an outline of what the tool is and what it does, with detail provided on what it can be used for. This also indicates which habitat types the tool covers, based on the UK National Ecosystem Assessment (NEA).[8] Examples of use in practice are included where relevant.
4. **The scale to which the tool applies:** i.e. national, specific regions, or global.

[7] Chazdon and Guariguata (2018) Decision support tools for forest landscape restoration: Current status and future outlook, https://www.cifor.org/publications/pdf_files/OccPapers/OP-183.pdf

[8] The UK NEA analysis identifies eight broad habitat types across UK terrestrial, freshwater and marine ecosystems, namely: Mountains, moors and heaths; semi-natural grasslands; woodland; enclosed farmland; Freshwater, wetlands and floodplains; urban; marine; and coastal margins. http://uknea.unep-wcmc.org/About/NEAReportStructure/tabid/62/Default.aspx

5. **Advantages:** for instance, low cost, open access, easy to use. Informed by the literature review and feedback from the six pilots.
6. **Disadvantages/drawbacks:** for instance, limitations to use, significant data requirements, or reliance on other capabilities/tools. Informed by the literature review and feedback from the six pilots.
7. **Relevant decision-making stage(s):** which of the five key decisions outlined in Section 2 of this guidance is the tool most relevant to. These are illustrated with the following icons:

8. **Access:** i.e. whether the tool is paid for or free and open access

A reference list for information contained in Table 3 can be found in the Endnotes.

Table 2: Summary of Tools Shortlist

Tool Name	Brief Description	Access
ADVANCES	Repository of natural capital data for analysis in landscape decision making.	✓
B£ST	Assigns monetary value to environmental benefits in blue-green projects.	✓
Biodiversity Metric 4.0	Habitat-based approach to assess an area's value to wildlife.	✓
CaBA Data Package	GIS layers for catchment-based river management.	✓
Circuitscape	Habitat connectivity analysis software.	✓
CRAFTY	Ecosystem services modelling and valuation.	✓
Cool Farm Tool	Calculates and analyses carbon footprint, biodiversity, and water quality on farms.	◐
InVEST	Suite of models to map and value ecosystem services.	✓
Land App	App-based UK GIS platform for use in the field.	◐
Land Use Choices Tool	Quantitative scoring tool to assess biodiversity, water quality and flood risk on agricultural land.	TBC
Marxan	Spatial prioritisation analysis software.	✓
MESER	Literature review of impact of landscape changes on ecosystem services.	✓
Natural Capital Evidence Handbook	Natural England's guidance on assigning value to natural capital.	✓
NEVO	Web application to spatially analyse ecosystem services.	✓
Spatial Planning and Monitoring of Landscape Interventions	Stakeholder engagement guide using maps as facilitatory tools.	✓

Table 3 Shortlist of decision support tools

Name of tool	Type of tool	Description and Purpose	Scale	Advantages	Disadvantages	Decision making stage	Access

ADVANCES (ADVancing Analysis of Natural Capital in landscapE decisionS) – UEA	Data repository	➢ **Online open access land use research directory, developed to enable better computer-based optimisation of land use decisions.**
		• Particularly relevant for projects looking at agriculture, biodiversity, and afforestation, but applicable to all 8 UK NEA habitat types.
		• The ADVANCES project develops and improves statistical analysis tools to incorporate uncertainty and multiplier effects on natural capital.
		• Three key features of tools developed by the project are:
		  • Considering trade-offs between food production and biodiversity, taking account of agricultural prices;
		  • Understanding context dependency, cumulative effects, and uncertainty propagation when managing landscapes for multiple benefits; and
		  • Assessment of biodiversity and cultural ecosystem services.
		• Potential users may be in the sectors of agriculture, forestry, renewable energy, and nature conservation.
			Global	Open-access platform which collates research on landscape decisions for easy navigation.
				
				Improves operational methods and guidance to improve assessment of natural capital in projects, taking account of uncertainty.
					Biodiversity and cultural ecosystem services are difficult to quantitatively assess and should be considered with caution.		

B£ST (Benefits Estimation Tool) – CIRIA	Guidance and Excel tool	➢ **An Excel spreadsheet tool with guidance on how to estimate and assess the financial, social and environmental benefits of blue-green infrastructure.** • Relevant to blue-green infrastructure, particularly drainage and natural flood management. Does not apply to UK NEA coastal or marine habitats. • Includes 15 monetised and three non-monetised benefit categories, (e.g., air quality, biodiversity, carbon reduction, flooding, health and tourism). • Requires users to input site and project specific data in Excel spreadsheets. It then identifies likely types of benefits and their potential significance and values the most significant benefits of the project, creating a bespoke estimate. • Provides downloadable PDF outputs which include summary tables, charts and graphs in which results are presented in terms of natural, social and other types of capital. Results are also presented in terms of ecosystem service (e.g., present value of provisioning, regulating, cultural and supporting services). • **Example**: Used by Yorkshire Water in Leeds to assess and compare the impact of options to reduce sewer overflow spills on ecosystem services. Comparing conventional options to sustainable drainage systems, the tool indicated the monetary value of the ecosystem services in present value and gave a benefit-cost ratio.	National	Consistent with broader government economic appraisal guidance. Suitable for users with general computer literacy and does not require specialist economic input. A simple assessment can be conducted without detailed input data (allowing for lower confidence in results). The B£ST Comparison Tool enables users to compare more than one assessment.	For the most robust and comprehensive results, more complete and detailed input data is required. The most recent, 2019, version of the tool provides monetary values in 2017 prices, which would not account for current inflation. The tool does not help the user understand biodiversity net gain, nor does it help the user understand the costs of undertaking the project.		

Name of tool	Type of tool	Description and Purpose	Scale	Advantages	Disadvantages	Decision making stage	Access
Biodiversity Metric 4.0 – Natural England	Interactive tools and guidance	➢ **Used to quantitatively assign a value to biodiversity in a given area.** • Relevant to biodiversity only and can be applied to all 8 UK NEA habitat types. • 'Biodiversity units' are numeric values which are calculated based on factors including habitat type, distinctiveness and condition. These units can be compared to assess impacts of land use changes on biodiversity, and to monitor biodiversity gains and losses. • Users can input habitat type, size of habitat (in hectares or kilometres, depending on habitat type), condition, and whether the site is identified as a priority area for nature. • The output is a score of biodiversity for the current or proposed habitat. It compares current habitat scores to proposed alternative habitat scores, and assesses whether the change will yield an improvement. This can then be used to rank potential alternative land use changes.	National	Developed specifically for the UK, to measure biodiversity net gain. Calculates the impact of proposed land management changes or land use changes on biodiversity. Can be integrated with GIS for spatial analysis.	Specific focus on biodiversity only. The metric is based on habitat uniqueness more than complexity and/or interconnectivity. Because of this, it is recommended that biodiversity units are not the sole basis for decision making. Does not provide natural capital optimisation.		

Catchment Based Approach (CaBA) Data Package – WaterCoG	Interactive tool	➢ **Set of GIS layers to enable river and water management at catchment level.**
		• Relevant to water catchments, in particular for flood risk and water quality.
		• Contains a series of GIS layers to be used in ArcGIS software for analysis. The multiple data layers enable assessment of multiple factors together on a spatial basis, enabling nuanced analysis by the user.
		• As well as base maps, some examples of data layers in each group are given below to showcase the variety offered through the Hub:
		  • Opportunities: Local Nature Partnerships layer for nature recovery;
		  • Issues: Nitrate Vulnerable Zones layer for lakes;
		  • Characteristics: National Forest Inventory for land use & land cover;
		  • Causes [of issues]: Authorised Landfill Site Boundaries for pollution;
		  • Action: NFM Assets for natural flood management; and
		  • Monitoring: River Flood Gauges and key nutrient indicators.
		• The outputs are therefore dependent on the combination of the layers input by the user
			National	Datasets are grouped for easy navigation depending on the research question.
				
				List of datasets is comprehensive, enabling a multitude of research questions to be answered.
				
				Can be integrated with local GIS datasets for more localised analysis.
					Geographical coverage of all datasets is not complete as the tool relies on individual projects to upload data. Some datasets may not cover certain catchments.
					
					Specific to landscape projects at river catchment level.
					
					Requires decision making by user as to how to integrate different factors into analysis.
					
					Some users reported that the application is can be slow and challenging to use.
							

Name of tool	Type of tool	Description and Purpose	Scale	Advantages	Disadvantages	Decision making stage	Access
Circuitscape – McRae *et al.*	Software	➢ **Habitat connectivity analysis software package to assess the impact of interventions on habitats and determine where best to make interventions.** • Relevant to all 8 UK NEA habitats, and to users considering the impact of landscape changes on plant and animal connectivity across landscapes. • Predicts patterns of movement, gene flow, and genetic differentiation in plant and animal populations in heterogenous landscapes. Potential applications include wildlife corridor design, landscape genetics and movement ecology. • The tool is run in Julia (a programming language). • Output is spatial data map showing how connected two pieces of habitat are. • **Example**: Circuitscape was used to show the connectivity impacts of Heathrow's expansion on bat and grass snake populations.	Global	Complements 'least cost path' approaches by considering all possible pathways across a landscape simultaneously. Optimises connectivity assessment which is typically subjectively carried out in conventional GIS tools.	Most suitable for large landscape projects – may be unnecessarily complex for smaller projects. Requires experienced modellers. Significant data needs to ensure a useful output.		✓
Competition for Resources between Agent Functional Types (CRAFTY) – KIT	Software	➢ **Model that simulates ecosystem services and the impact of land use changes.** • Relevant to agriculture, forestry, urban and conservation land uses. Can be applied to all 8 UK NEA habitat types. • The model works by applying processes (including production, competitiveness, and demand) to spatial cells to determine the resulting state of the landscape. The features of the model dynamically interact, meaning the user can simulate the impact of a key change (for example a land use change) on cells' attributes (i.e. ecosystem services and production capacity). • The model has comprehensive documentation to enable users without programming experience to use it. It is designed to model land use changes across large spatial extents efficiently. It is highly flexible and can handle a wide variety of data and applies to a range of empirical and theoretical questions. • **Example**: One example application of CRAFTY is a study which considered the impact of soybean production in Brazil on land use in distant but coupled China. This illustrates the tool's use in assessing wider socioecological impacts of local decisions, enabling transboundary decision making.	Global	Efficiently simulates a wide range of land uses across large geographical extents to a high level of spatial granularity (1km^2). No need for programming expertise.	Most suitable to large-scale projects that require significant data processing, and so may be unnecessarily complex for smaller projects.		✓

Name of tool	Type of tool	Description and Purpose	Scale	Advantages	Disadvantages	Decision making stage	Access
Cool Farm Tool – Cool Farm Alliance	Software	➢ **Web-based greenhouse gas, water and biodiversity footprint calculator.** • Relevant to agricultural land only. • Designed to inform users on sources of greenhouse gas emissions, blue and green water footprints and biodiversity, and offer mitigation options. Calculations are comprehensive and fully referenced. • For a greenhouse gas footprint, users input product weights, growing area, fertiliser application, transport details, and livestock data including numbers, manure management, and feed. • For a water footprint, users input irrigation data, or indicate if agriculture is purely rain fed. • For a biodiversity footprint, users do not need specialist knowledge, rather input practices implemented on farms and areas not in active production. • It is free to carry out up to five assessments with the tool. Users must pay for an upgrade if they wish to aggregate data across assessments or share data. This also unlocks climate literacy training.	Global	Enables tracking of environmental impacts and improvement over time. Can be used to communicate environmental benefit by quantifying impact. No specialist knowledge required.	Applicable only to individual farm assessments. Free version can be used for up to five assessments only – not suitable for decision-makers at a larger scale. Cannot integrate assessments (greenhouse gas, water and biodiversity) under free version which limits decision making.	 	 
Integrated Valuation of Ecosystem Services and Trade-offs (InVEST) – Stanford University	Suite of software models	➢ **Creates estimates of the value of ecosystem services in a particular land or seascape, and enables users to identify where investment in natural capital will best support landscape conservation and human development.** • Particularly useful for large scale analysis, especially for users working within time constraints, as it is a simplified system for ecosystem valuation. Relevant to all 8 UK NEA habitat types. • Helps explore how changes within ecosystems can lead to changes in the flows of different benefits to people. • Provides biophysical outputs that sit alongside its economic valuation of ecosystem services. This allows the user to see the physical changes in landscape, as well as the potential cost, helping to inform land management decisions. • Inputs primarily require GIS/map data. Outputs are in the form of maps, quantitative data on ecosystem services, tables and statistics. • Flexible spatial resolution allowing analysis at local, regional or global scales. • A comprehensive user manual makes it more accessible.	National	Helps assess quantified trade-offs associated with alternative management choices. Identifies areas where investment in natural capital can enhance conservation. Includes a number of "helper tools" for processing data and visualising outputs. No technical expertise required for use e.g. no knowledge of Python programming is required.	InVEST models are a standalone application. GIS software, like QGIS or ArcGIS, are needed to view results. Users will need GIS mapping skills. Water and nutrient retention models are annual; more detailed temporal analysis is not possible.		

Name of tool	Type of tool	Description and Purpose	Scale	Advantages	Disadvantages	Decision making stage	Access
Land App – Land App	Interactive app	➢ **A mapping application that can be used to identify where to implement land use changes, to support mapping and managing projects and to identify available grants.** • Relevant to all 8 UK NEA habitat types except marine, coastal and urban. • A UK GIS platform that provides users with mapping tools and data layers (e.g., land registry tools, statutory designations, flood zone areas, and other access data) in a mobile application. • Has a suite of project templates- baseline habitat assessments and land management plans- that can be easily adapted based on the relevant landscape and area, meaning analysis does not have to be started from scratch. • Can also support users to identify essential stakeholders to the landscape and provides an overview of grants and funding that may be available on particular types of land. • Extensions to Land App will allow users to access all eligible land for tree planting, identify which sites are higher value under the England Woodland Creation Offer scheme (EWCO) and forecast the carbon impact of those woods based on the woodland carbon code.	National	Can be used in the field as an app. Particularly useful for organisations that have fewer resources dedicated to GIS mapping and spatial analysis.	Unlikely to be a standalone tool for a landscape restoration project. Does not provide the same level of spatial analysis and modelling sophistication as traditional GIS tools. Does not apply to marine, urban or coastal habitats.		
Land Use Choices Tool – ADAS & EA	Tool/ framework	➢ **A "scenario generation" tool that supports decisions about suitable locations for new habitat or woodland creation on agricultural land.** • Can optimise for and deliver multiple environmental benefits across Defra's Environmental Improvement Plan priorities taking account of national and local constraints. Specifically developed for agricultural land managers working within catchments. • Generates outputs that meet the user's specific input priorities. These can be any combination of modules and sub-module choices e.g. to plant woodland for flood risk but only on non-agricultural land. Scenarios can also include best-value benefit, maximum cost-effectiveness or can be run to address specific targets such as offset mitigation requirements for housing, reduce nitrogen or phosphorus loss or net zero targets, as examples. • Calculates the costs and relative benefits of the scenario interventions including habitat or woodland creation, maintenance and income foregone from food production, pollution reduction, flood damage averted, etc • Operates at regional to local scale currently. • Spreadsheet outputs can be represented in GIS or mapped format. Post-processing codes allow for the summary of data into tables and graphs.	National	Incorporates local datasets and knowledge to provide bespoke decision support on targeting land use change or changes in management. Data used at a national level can be replaced with local level data, which creates more spatially specific outputs. Scenario outputs can be compared to optimised outputs to assess relative trade-offs e.g. income loss.	Currently a prototype and not available to the public. A tool for catchments only.		TBC

Name of tool	Type of tool	Description and Purpose	Scale	Advantages	Disadvantages	Decision making stage	Access
Marxan – Environment Australia	Spatial analysis software	➢ **Supports land management by assessing environmental and human impacts, and potential trade-offs of decisions taken in a particular landscape.** • A systematic conservation planning spatial software that uses national and local level data to help make decisions about the designation of protected areas. Relevant to all 8 UK NEA habitat types. • Enables choice of factors for analysis by user. • Can provide an indication of project costs. • Most useful in large-scale restoration activities, where there are a series of complex planning problems, and a variety of trade-offs that make it difficult to identify a clear solution. • **Example**: Used to identify where nature recovery networks may be implemented in the UK, based on fragmentation in landscapes, while helping decision-makers to understand where they could limit costs.	Global	Provides an assessment of environmental, human development and financial trade-offs to help inform decision making. Useful in large-scale restoration activities that may encounter a range of planning problems.	Some gaps in the data underpinning the tool as it is global, and not specifically designed for small or local UK projects. Users need to understand/be familiar with systematic conservation planning. Requires specialist software expertise to use.		
Managing Ecosystem Services Evidence Review (MESER) – Natural England	Evidence repository	➢ **Searchable literature review which collates best-available evidence on impact of landscape interventions on ecosystem services.** • Relevant to all 8 UK NEA habitats but particularly to coastal and marine, freshwater, lowland agriculture, uplands and urban settings. • For each habitat type, users can navigate to evidence relating to the impact of a specific landscape change on ecosystem services. • Each landscape change has a factsheet with an initial 'scorecard' that shows the magnitude of impact and the consensus amongst available evidence. It then provides a more detailed review split into provisioning, cultural and regulating ecosystem services. A full reference list is also provided. • The platform also assesses the transferability of impacts on ecosystem services if the landscape change were to be carried out elsewhere, enabling users to determine where interventions should be applied.	Northern Europe	Indicates level of agreement in literature which enables users to make informed decisions. Easy to navigate with no technical expertise. Evidence covers a range of habitats.	Landscape interventions are not exhaustive meaning this resource may not be useful in all cases. Requires user to combine analysis together to enable decision making Evidence was collated in 2014 and may be outdated.		

Name of tool	Type of tool	Description and Purpose	Scale	Advantages	Disadvantages	Decision making stage	Access
Natural Capital Evidence Handbook – Natural England	Guidance	➢ **Provides economic values of ecosystem services, indicating the natural capital of various land uses which can be used to identify where investment in a landscape should be prioritised.** • Guidance, produced by Natural England in line with the UK's 25 Year Environment Plan, that sets out how to include natural capital evidence in decisions around land management. This is intended to show which aspects of a landscape should be prioritised over others in planning decisions, based on the quantified value of the benefits of natural capital. Relevant to all 8 UK NEA habitat types. • Created a six stage approach to valuing natural capital in the UK, which users can apply to their project. Helps to forecast drivers of change and understand the impact of external pressures that may change the value of natural capital over time. • **Example**: Used to assess the natural capital of Tees Valley, creating a baseline as a reference for any future assessments following implemented changes.	National	Covers a wide range of ecosystem services and is widely used, particularly across government projects. Useful communication tool for demonstrating benefits of land use change.	The valuation process for a given ecosystem service may not be applicable in specific project contexts: projects should be sure to understand the context of the services and their project when using these.		
Natural Environment Evaluation Tool (NEVO) – LEEP	Interactive tools and guidance	➢ **Provides estimates of the value of any area in England or Wales for delivering a range of ecosystem services (e.g., timber or agricultural production), as well as estimates for biodiversity (e.g. estimated number of species present).** • The online tool allows users to select an area anywhere in England or Wales, from the county/catchment scale down to a 2km grid cell. It then provides quantitative data on ecosystem services in that selected area. From this, it makes predictions and quantifies the benefits that are derived from existing and altered land use. Relevant to all UK NEA habitat types except marine environments. • User can alter land cover and market prices to understand how changes may affect ecosystem services now and in the future. • User can set the objective of the analysis, enabling optimisation of outputs. • It is focussed on enabling comparison of economic valuations of land use decisions across scales in a spatially explicit way.	National	Users can specify the type and area of land use change, as well as the overall objective e.g. to maximise particular quantity outputs (e.g. biodiversity richness) or value outputs (e.g. timber and agricultural profits). Does not require any specialist expertise.	The tool goes down to 2km, which in many cases will not be granular enough (e.g. for local projects, many will want to see down to 50m or closer). As a result, it is more useful for large-scale landscape projects as opposed to local scale projects, due to the way the tool uses spatial data. Useful communication tool for demonstrating benefits of land use change.		

Name of tool	Type of tool	Description and Purpose	Scale	Advantages	Disadvantages	Decision making stage	Access
Spatial Planning and Monitoring of Landscape Intervention – EcoAgriculture Partners	Guidance	➢ **Provides guidance on how to involve stakeholders at every stage of agricultural landscape projects, particularly at different spatial levels where input will look different (e.g. government engagement vs local community buy-in).** • Uses best available maps to facilitate the engagement process by allowing stakeholders to specifically indicate areas where improved landscape benefits should be planned and monitored. Relevant to mountains, moors and heaths, semi-natural grassland, enclosed farmland and woodland. • Guidance is split in such a way that elements can be 'cherry picked' by projects and applied in their specific context. • Provides users with guidance on creating a partnership model that uses collaborative engagement methods in order to mobilise investment. • Provides advice on co-ordinating a potentially diverse set of stakeholders. • This therefore supports decision making by enabling high quality engagement of stakeholders.	Global	Provides guidance on selecting, accessing and tailoring maps that form the crucial basis of this spatially explicit multi-stakeholder planning process.	There will be nuance in fostering project-community relationships, which will be place specific, that a guidance document will not be able to fully account for. It may not support the user in having landowner or financial discussion.		

4.0 Other useful resources

In addition to the shortlist of tools above, Table 4 provides additional useful resources for landscape restoration projects.

The tools included in the table below are not decision support tools as per the definition outlined in Section 3.1, i.e. they do not tell you the answer to a question.

However, they are necessary in order to use some of the tools in the shortlist in Section 3, and/or provide wider detail and context that may be beneficial when planning landscape projects.

The resources include:

1. GIS and related software, key to using many of the tools in the shortlist;
2. The GFI Toolkit for investment readiness, to support project planners seeking private finance;
3. OrVal which is a metric to quantify the recreational benefit of outdoor spaces;
4. Two directories of tools and resources: Enabling a Natural Capital Approach (ENCA) featured tools and the Ecosystem Knowledge Network;
5. The UK Land Carbon Registry as a key database; and
6. A summary of the new Government guidance on combining environmental payments (stacking).

Table 4: Additional Resources and Guidance

Resource	Type	Description	Link
Spatial Analysis Tools: GIS (including ArcGIS and QGIS) and Python	Spatial analysis software	Geographic Information System (GIS) tools enable users to create, edit, and analyse geospatial information. Interviews with the pilot projects noted GIS tools in particular as being commonly used during project design and implementation. Some form of GIS software is required in order to use the CaBA data package and InVEST tools on the shortlist. ArcGIS is a paid GIS software with various licence levels offering users access to specific 'tools' within the programme. For example, ArcGIS Field Maps is a tool which allows users to capture and edit data in the field using web maps. Interviewees reported that ArcGIS can be easier to use that other GIS tools. However, significant costs (£799-£6,242 per year) to unlock functionality can be a barrier to use. QGIS is a free version of this software which is widely used due to its comprehensive capabilities. Its open-source nature may be a benefit to some, however this can lead to some performance issues and slightly limits the capacity of the tool to carry out more complex analysis. The direction of travel in spatial analysis is heading towards automation and programming.[9] For example, spatial	ArcGIS ArcGIS Field Maps – The all-in-one app for fieldwork QGIS – A Free and Open Source Geographic Information System Python

[9] Langhammer et al. (2019) Agricultural landscape generators for simulation models: A review of existing solutions and an outline of future directions, https://www.sciencedirect.com/science/article/abs/pii/S0304380018304216

Resource	Type	Description	Link
		mapping applications of the programme Python can be used to compare or repeat analysis across multiple sites, with benefits for larger-scale projects. While more computer programming skills are required than for GIS tools, Python is one of the easier languages to learn, and is vastly more efficient than conventional GIS tools for handling a large volume of information.	
Green Finance Institute (GFI) Investment Readiness Toolkit	Guidance	The GFI Toolkit is an online and interactive framework that provides eight key stages for UK nature-based projects seeking to use private finance. It comprises a 'snake' infographic made up of key project planning milestones covering: 1. Initial project scoping 2. Identifying and working with sellers 3. Baselining and Estimating Ecosystem Services 4. Identifying and working with buyers 5. Developing a business case and financial model 6. Developing a governance structure 7. Identifying and work with investors 8. Establishing and closing legal contracts The toolkit includes case studies, checklists and useful links for each stage.	GFI Investment Readiness Toolkit
ORVal (Outdoor Recreation Valuation tool)	Interactive tool and guidance	ORVal can be used to predict visits to outdoor spaces and translate the welfare benefit of these visits into monetary value, thereby valuing the economic benefit of outdoor spaces to recreation. Users can manipulate the land cover of areas to assess the impact of landscape changes on recreational benefit of the landscape, as an assessment metric. Inputs are pre-built into the tool – the user need simply select the landscape in question and/or specify the land cover of interest. Outputs include maps, statistics, cost-benefit assessment, and quantitative data on ecosystem services.	Outdoor Recreation Valuation Tool (ORVal: Version 2.0)
ENCA featured tools for assessing natural capital and	Tool and resource directory	Enabling a Natural Capital Approach (ENCA) featured tools is a suite of natural capital or valuation tools provided by Defra. These include analytical tools as well as links to platforms which assess natural capital tools.	ENCA featured tools for assessing natural capital and environmental valuation -

Resource	Type	Description	Link
environmental valuation		The tools cover various ecosystem services and habitats and have been developed or funded by Government. The tools include: • Tool Assessor; • Defra Biodiversity Metric; • Environmental Benefits for Nature Tool; • Natural Capital Atlases; • Natural Capital Register and Account Tool; • Managing for Ecosystem Services Evidence Review Toolkit; • Local Environment and Economic Development (LEED) Toolkit; • Environmental Valuation Reference Inventory (EVRI); • Natural Environment Valuation Online (NEVO); • Outdoor Recreation Valuation Tool (ORVal); and • Woodland Valuation Tool.	GOV.UK (www.gov.uk)
Ecosystem Knowledge Network Tool Assessor	Tool and resource directory	Produced by the Ecosystem Knowledge Network (EKN), the Tool Assessor is an online resource which describes and assesses a range of tools for local application. The Tool Assessor helps users decide which tool would be best suited for their analysis, by outlining how the tool works, limitations and considerations and case studies. The tools are organised into the following categories: • Methods, principles and checklists; • Mapping ecosystem services; • Expressing values in monetary terms; • Calculating offsets or net gain; and • Quantifying nature's services without mapping.	Tool Assessor - Ecosystems Knowledge Network
UK Land Carbon Registry	Database	The UK Land Carbon Registry is a public store of data about the status of Woodland Carbon Code and Peatland Code projects. It records transactions and provides data on the ownership and use of UK -based Woodland and Peatland carbon units. Potential to support the identification of carbon credit buyers.	UK Land Carbon Registry - UK Woodland Carbon Code
Combining environmental payments: biodiversity net gain (BNG)	Government guidance	In February 2023, Defra and Natural England published guidance on combining (or "stacking") environmental payments i.e., selling multiple environmental credits or units - such as biodiversity net gain (BNG) and nutrient mitigation - separately from the same activity on a piece of land.	Combining environmental payments: biodiversity net gain (BNG) and

Resource	Type	Description	Link
and nutrient mitigation		The guidance states that biodiversity units and nutrient credits can be stacked, provided the eligibility criteria is met for each market. They can also be stacked with voluntary carbon sales (i.e. through the Woodland Carbon Code (WCC) and Peatland code) provided that nature recovery activities are additional to what the voluntary scheme paid for. For instance, the environmental baseline for calculating BNG or nutrient credits must take into account the land use change required to generate the carbon credits, and not the current land use. In practice, passing these eligibility and additionality requirements may make stacking with carbon difficult. The guidance also sets out rules for stacking credits with public sources of money and Corporate social responsibility (CSR) payments.	nutrient mitigation - GOV.UK (www.gov.uk)

Appendix

A 1.0 Project background

The Environment Agency is participating in a joint Shared Outcomes Fund called Nature-based Solutions (NbS) for Climate Change at the Landscape Scale. The project, which is led by Natural England, the Environment Agency, RBG Kew and the Forestry Commission, is working with local partners and stakeholders in six new pilot study areas to develop effective ways to integrate NbS with other land management objectives. The pilot projects are spread across England and include:

1. Wild Exmoor Carbon Sequestration Project;
2. Plymouth's Natural Grid;
3. Wansbeck Restoration for Climate Change;
4. Oxfordshire-Buckinghamshire Freshwater Network;
5. Severn Solutions for Nature's Recovery; and
6. Derwent Forest Landscape Recovery Project.

As part of these projects, the local habitats will be researched and monitored, while new blended finance models will be developed and assessed. The project aims to test the efficacy of different NbS for carbon sequestration and to provide a pathway to large-scale implementation.

To support the pilot projects, the Environment Agency commissioned Eunomia to develop guidance on key decision-making stages for landscape restoration projects and relevant tools to assist those key decisions. Tools include software, databases, applications and guidance resources. This guidance document intends to support and inform the six pilot projects, as well as others carrying out landscape restoration projects, by providing the following information:

- A summary of the key decision-making stages expected to be made during a landscape restoration project;
- A shortlist of available tools to help at each decision-making stage, including a description of each tool, its purpose, advantages and disadvantages, accessibility and cost;
- A collection of additional useful resources and guidance; and
- A long list of available tools and resources in the Appendix.

Approach

This guidance is based on information from a literature review and interviews with the six pilots under the NbS for Climate Change project. The literature review identified the key decisions made during habitat restoration and conservation projects, the steps nature-based solutions projects can take to attract private finance and a 'long list' of tools available to support these processes (see Appendix).

The interviews gathered information on the tools and resources that pilot projects have used to support decision making, and the pros and cons of different tools which the pilots have experienced. The experience of

the pilot project interviewees and internal expertise was used to prioritise a ‘shortlist’ of tools considered most useful.

A 2.0 Broad stages in a landscape restoration project

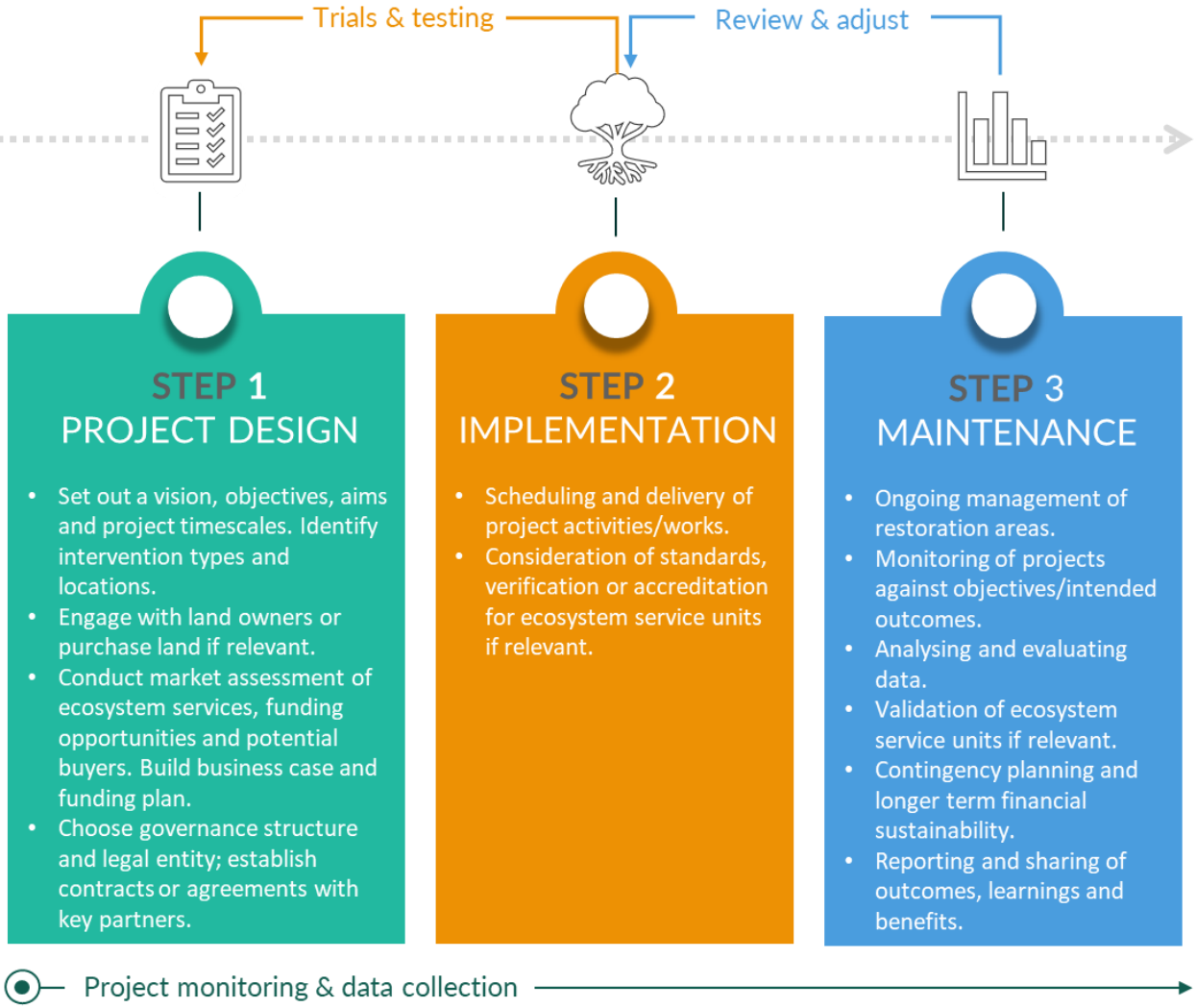
Throughout the duration of the project

STAKEHOLDER ENGAGEMENT

- Identify and engage with key stakeholders and partners, e.g. land owners/managers, local communities, eNGOs, local authorities and relevant government bodies.
- Identify the risk appetites, skills and knowledge of key partners, as well as concerns or requirements of people likely to be affected.
- Identify potential beneficiaries and buyers of ecosystem services such as local businesses, infrastructure and minerals companies, water companies and housing developers.

POLICY AND REGULATORY CONTEXT

Be aware of how the project will be affected by current and future policy. This includes emerging codes, standards and market frameworks for ecosystem services, as well as future funding schemes.



A 3.0 Shortlisting Criteria

The criteria in Table 5 were used to develop the shortlist of tools. The criteria were developed based on the interviews with pilot projects, the Forests, Trees and Agroforestry research program's *A collection of tools for land restoration*[10], the 1000 Landscapes for 1 Billion People initiative's *Integrated Landscape Management Tool Guide*[11], and from the experience of Eunomia's landscape restoration experts.

Table 5: Shortlisting Criteria

Criterion	Assessment Method
Ease of use	Can the tool be used without technical knowledge? Is it accessible using simple technologies? Is any training/ upskilling required?
Familiarity	Is the tool currently used by the pilot projects? Have they heard of the tool?
Cost	Is the tool open and/ or affordable?
Wider applicability	Can the tool by used in a wide range of landscape types?
Use in field	Can the tool be used out on site? Is any equipment or connectivity required to use the tool in the field?
Type of outputs	Are outputs useful, directly applicable to landscape initiatives, and shareable? Are shareable outputs in an easy-to-interpret format?

The criteria were used in a qualitative manner to determine if a tool should be included in the shortlist, but were not applied strictly, in order to allow for 'gold standard' tools to be included. The shortlist consequently ensures that all criteria are met by at least one tool, but not all tools in the shortlist meet all the criteria. For example, very few tools in the shortlist can be used in the field – the inclusion of Land App in the shortlist fills this gap. Conversely, the Cool Farm Tool is one of few tools in the shortlist that has a cost associated – its inclusion in the shortlist is because it meets the other criteria of being easy to use, with useful and shareable outputs.

[10] Pingault et al. (2021) A collection of tools for land restoration, https://www.cifor.org/publications/pdf_files/FTA/WPapers/FTA-WP-13.pdf
[11] 1000 Landscapes for 1 Billion People (2022) Integrated Landscape Management Tool Guide, https://landscapes.global/wp-content/uploads/2022/07/ILM_Tool_Guide.pdf

A 4.0 Long list of tools and resources

The following list was compiled through a literature review of tools and resources as well as discussion with Eunomia's internal natural capital, ecosystem services and biodiversity experts. These tools focus on spatial analysis, ecosystem services, habitat restoration and spatial mapping. The list was refined through research throughout the literature review, and, crucially, through interviews with the pilot projects about the tools they use; through this process the shortlist was created. The long list of tools is provided in Table 6 for reference, as it may be of use to some organisations who are looking for a wider purview of tools.

Table 6: Long List of Tools and Resources

Name	Type of Resource	Description & Purpose	Scale	Access
A collection of tools for land restoration	Database	Aa compilation of existing restoration tools developed by CGIAR research programmes (CRPs), CGIAR centres and partner organizations. The objective is to inform the different stakeholders involved in FLR at different scales (policy makers, forest managers and restoration practitioners, land owners, project managers, conservation organizations, students and researchers) and help them navigate through the huge diversity of existing restoration tools that can be used to support the design, implementation and assessment of restoration projects as well as on the range of topics and issues for them to consider. This compilation gathers a collection of short information sheets on existing FLR tools, developed following a common template.	National	Open
A Practical Guide to Integrated Landscape Management	Guidance	The Practical Guide for ILM outlines an adaptive, collaborative and iterative process to help stakeholders achieve transformational change in their landscape. Focuses on the structure and process for effective collaborative landscape management.	Global	Open
Aries	Software	Provides extension on ecosystem services; web-based application built on the k.LAB Integrated Modelling Platform.	Global	Open
AutoCAD	Software	A commercial computer aided design and drafting software.	Global	Paid

Name	Type of Resource	Description & Purpose	Scale	Access
BlueSky Map Shop	Database	A web portal selling high-resolution, up-to-date geographical data including aerial photography, Digital Terrain and Surface Models, LiDAR and height data, national tree and soil maps, OS products and flood mapping. Free geographical data is also available.	UK	Free and paid data
Cartographer for River Condition Assessment	Software	An integrated monitoring, mapping, and data interpretation platform for environmental groups, that supports major GIS and data science tools like QGIS, ArcGIS, and Excel.	National	Paid
Century and DayCent: Daily Century Model	Software	The CENTURY model is a general model of plant-soil nutrient cycling which has been used to simulate carbon and nutrient dynamics for different types of ecosystems including grasslands, agricultural lands, forests and savannas. DAYCENT is the daily time-step version of the CENTURY biogeochemical model, simulates fluxes of C and N among the atmosphere, vegetation, and soil. Useful for those in the planning and/or monitoring stages, who want to track and stimulate fluctuation of carbon and nitrogen in the soil, atmosphere and/or vegetation daily.	National	Open
Co$ting Nature	Software	Co$tingNature is a sophisticated web-based spatial policy support system for natural capital accounting and analysing the ecosystem services provided by natural environments identifying the beneficiaries of these services and assessing the impacts of human interventions.	Global	Open

Name	Type of Resource	Description & Purpose	Scale	Access
Decision support tools for forest landscape restoration: Current status and future outlook	Application	The tool provides decision support for the monitoring of forest-water interactions based on different contexts and situations. Adjustable as to the data availability (how to collect baseline data, how to built on in existing baseline data - to better measure these indicators and take into account a wider range of issues that will be key for future management plans). Integrated with other state of the art data systems. Provides guidance on current, trustworthy and widely used methodologies. Provides an innovative approach to forest-water monitoring that may be applied at different management scales.	National	Open
Defra MAGIC	Interactive Website	Information covers rural, urban, coastal and marine environments across Great Britain. Presented in an interactive map which can be explored using various mapping tools.	National	Open
DraftSight	Software	A free design and drafting software program that you can use for CAD projects and 2D drawings.	Global	Paid
EA Natural Capital Accounts and Register	Guidance	Free online resource on analytical tools that link the environment and society; helps users understand what tool they should use.	National	Open
EcoservR	Software	The toolkit generates an environmental baseline classifying over 200 habitat types and uses spatial models to map their capacity to provide a range of ecosystem services, as well as the demand for them.	National	Open
ECOSSE Model	Software	A model for both organic and mineral soils that will help to provide more accurate values of net change to soil C and N in response to changes in land use and climate and may be used to inform reporting to GHG inventories. The main aim of the model is to simulate the impacts of land-use and climate change on GHG emissions from these types of soils, as well as mineral and peat soils. Most useful for those who want to assess the soil quality and profile up to 3 m depth, for soil restoration, forestry management and wider habitat restoration.	Global	Open

Name	Type of Resource	Description & Purpose	Scale	Access
Environmental Benefits from Nature Tool	Guidance	The Environmental Benefits from Nature tool is designed to work alongside Biodiversity Metric 4.0 and provide developers, planners and other interested parties with a means of enabling wider benefits for people and nature from biodiversity net gain.	National	Open
Environmental Valuation Reference Inventory (EVRI)	Guidance	A searchable storehouse of empirical studies on the economic value of environmental assets and human health effects. These summaries provide detailed information about the study location, the specific environmental assets being valued, the methodological approaches and the estimated monetary values along with proper contextualisation.	National	Open
Green Infrastructure Valuation Toolkit	Interactive tool and guidance	The toolkit provides a set of calculator tools, to help assess an existing green asset or proposed green investment.	National	Open
Habitat Network Maps	Guidance	Maps provide a national overview of the distribution of habitat networks with suggestions for future action to enhance biodiversity.	National	Open
I-tree-Eco	Software	A flexible software application designed to use data collected in the field from single trees, complete inventories, or randomly located plots throughout a study area along with local hourly air pollution and meteorological data to quantify forest structure, environmental effects, and value to communities.	National	Open
Mapping-tool Developed by the Gloucestershire Wildlife Trust	Interactive tools and guidance	Uses least cost nature recovery networks, by uses series of data sets, prioritizing the data and producing the local nature recovery map (habitat mapping system).	National	Paid
Maxent	Software	From a set of environmental (e.g. climatic) grids and georeferenced occurrence localities, the model expresses a probability distribution where each grid cell has a predicted suitability of conditions for the species. Under particular assumptions about the input data and biological sampling efforts that led to occurrence records, the output can be interpreted as predicted probability of presence, or as predicted local abundance.	Global	Open

Name	Type of Resource	Description & Purpose	Scale	Access
Natural Capital Atlases	Guidance	Guidance shows the state of natural capital for forty-four county or city regions across England. The atlases map out key properties of the environment to show how much, how good and where your natural habitats are.	National	Open
Natural Flood Management	Guidance	Tool helps manage flood and coastal erosion risk, by protecting, restoring and emulating the natural processes of catchments, rivers, floodplains and coasts.	National	Open
R Spatial	Software	These resources teach spatial data analysis and modelling with R. R is a widely used programming language and software environment for data science. R also provides unparalleled opportunities for analyzing spatial data and for spatial modelling.	Global	Open
Scale Sequence Joint Deep Learning (SS-JDL) for land use and land cover classification	Research	In this paper, a simple and parsimonious scale sequence joint deep learning (SS-JDL) method is proposed for joint large - scale land use and land cover classification, in which a sequence of scales is embedded in the iterative process of fitting the joint distribution implicit in the joint deep learning (JDL) method, thus, replacing the previous paradigm of scale selection. Often the optimal scale selection processes in land management and habitat restoration are extremely cumbersome and time-consuming requiring repetitive experiments involving trial-and-error procedures, which significantly reduce the practical utility of the corresponding classification methods. This research that SS-JDL works much more effectively when a user needs to classify large-scale land use.	National	Partially open – Science Direct
Structures for social enterprises	Guidance	UnLtd, in conjunction DLA Piper UK LLP, has developed a Social Enterprise introduction and Glossary, as a basic guide to assist social entrepreneurs when considering possible structures for their Social Enterprises.	Global	Open
TESSA	Guidance	The TESSA toolkit is designed to overcome obstacles by providing practical guidance on how to identify which services may be significant at a site of interest, what data are needed to measure them, what methods or sources can be used to obtain the data and how to communicate the results.	Global	Open

Name	Type of Resource	Description & Purpose	Scale	Access
The Local Environment and Economic Development (LEED) Toolkit	Interactive tools and guidance	LEED is the world's leading green building project and performance management system. It delivers a comprehensive framework for green building design, construction, operations, and performance.	National	Paid
The NATURE Tool (Nature Assessment Tool for Urban and Rural Environment)	Interactive tools and guidance	The NATURE tool is a user-friendly and easy to use Excel tool which will help you assess the impact of land-use and management changes on natural capital performance with the aim of achieving net gains for the environment.	National	Open
The Place Standard Tool	Interactive tools and guidance	The Place Standard is a simple tool to structure a conversation about a place. It helps people to think about both the physical and social aspects of places, and the important relationship between them.	Global	Open
UK CEH land cover map	Database	The UK CEH land cover map 2021 provides a 10m pixel dataset representing the land surface of Great Britain. The land is classified into 21 UKCEH land cover classes based on Biodiversity Action Plan broad habitats.	Great Britain	Open
We Value Nature Capital Assessment Module	Interactive tools and guidance	The WVN training materials are centered around the Natural Capital Protocol, a decision-making framework that enables organisations and business to identify, measure and value their direct and indirect impacts and dependencies on natural capital.	EU	Open
Woodland Valuation Tool	Interactive tools and guidance	The Woodland Valuation Tool (WVT) was developed in 2015 (and updated in 2018) as part of the Scoping study on valuing the social and environmental benefits of trees and woodlands in England, Scotland and Wales, funded by the Forestry Commission.	National	Open

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