Nature Recovery Blueprint

Guiding the renewables industry towards nature positive management practices

2024

Foresight

eden project

Contents

Front cover image
Plug planting at Foresight solar site

Foresight.Group

Foxgloves

1. Introduction

In this section:

Why do we need to contribute to nature recovery?

According to the World Economic Forum, over half of the world's GDP – $44 trillion of economic value generation, is at moderate or severe risk due to nature depletion, with a fifth of nature's ecosystems on the verge of collapse. To mitigate these risks, the State of Finance for Nature report highlights the need for a total investment in nature of $8.1 trillion between now and 2050 to effectively address the interlinked climate, biodiversity, and land degradation crises.

Renewable energy sites, like solar farms, offer comparatively undisturbed environments and long-term ownership or lease agreements, making stakeholders uniquely positioned to contribute to biodiversity and nature recovery efforts. Even slight adjustments to management practices or cost-effective interventions can yield significant biodiversity improvements in a remarkably short time frame. For instance, wildflowers can flower within 12 weeks of sowing, while implementing a no-mow regime during summer months can yield biodiversity returns in just weeks.

Foresight is a leading listed infrastructure and private equity investment manager, managing over 400 diversified infrastructure assets with a focus on solar and onshore wind assets, bioenergy and waste, as well as renewable energy enabling projects, energy efficiency, management solutions, social and core infrastructure projects and sustainable forestry assets[1].

Foresight is a leading listed infrastructure and private equity investment manager, overseeing a portfolio of over 400 diversified infrastructure assets. Our focus spans solar and onshore wind assets, bioenergy and waste projects, as well as renewable energy enabling initiatives, energy efficiency solutions, social and core infrastructure projects, and sustainable forestry assets. Specifically in solar, Foresight manages over 80 sites in the UK, 80 in Europe, and 15 in Australia.

1. As at 24 April 2024.

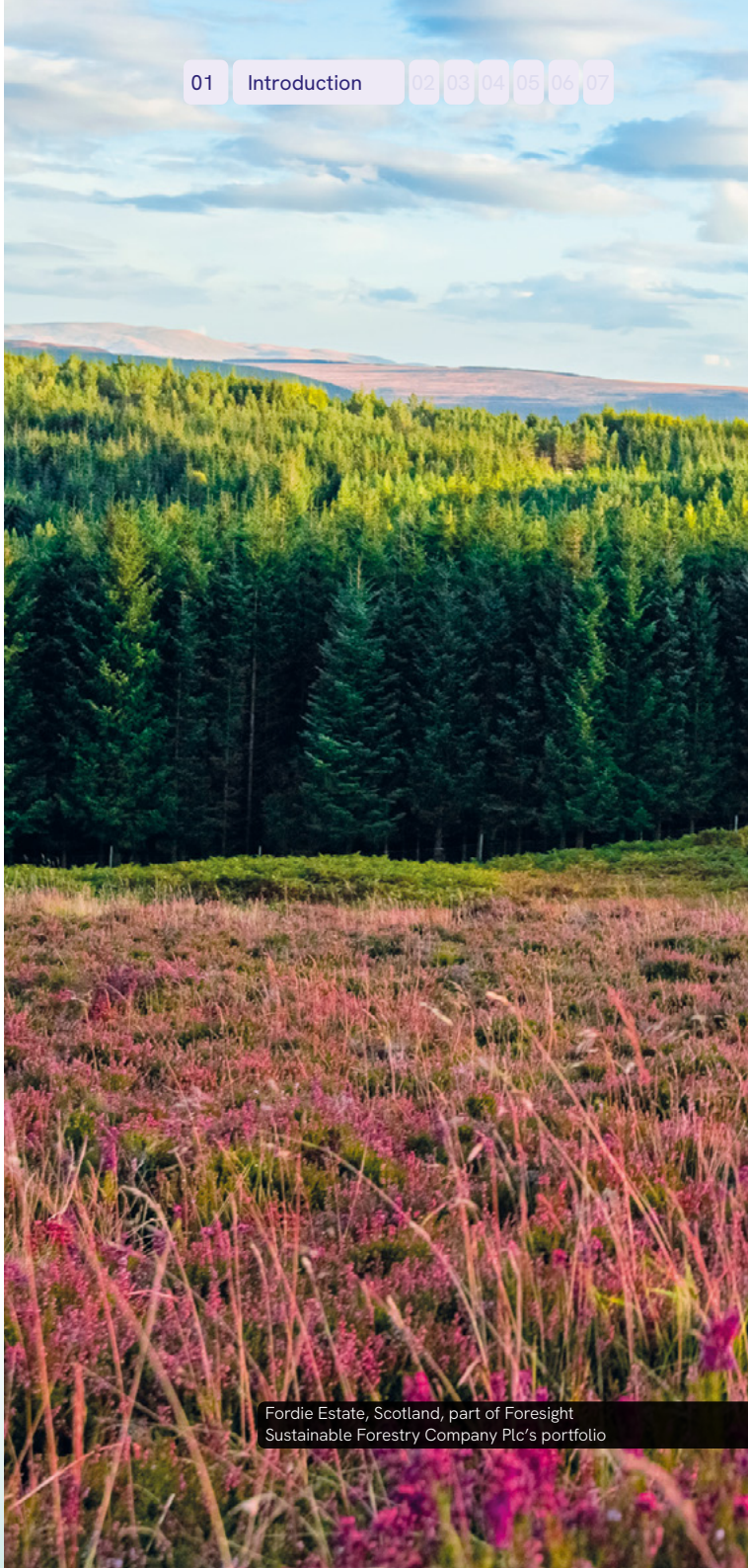
As stewards and land managers, we are committed to enhancing biodiversity across our sites, informing our management techniques, and enriching the surrounding natural ecosystems. Our goal is to leave the land and its inhabitants in a better state than we found it. Collaboration is essential in shaping the path to a nature-rich future.

Challenges such as habitat deterioration, loss, pollution, and invasive species, demand cross-sector cooperation for effective solutions.

Investing in nature not only benefits the environment but also brings advantages to both local and global economies. It enhances resilience to future challenges and contributes to climate change mitigation through nature-based solutions. For businesses especially, motivations include gaining a competitive edge in a sustainability-focused world, commercial benefits from Biodiversity Net Gain units, fulfilling stewardship responsibilities, aligning with upcoming nature-focused regulations, and pre-emptively adapting to changing agricultural and land management policies. Working together both public and private sectors, can initiate actions against biodiversity loss by identifying opportunities to enhance biodiversity on their land holdings.

The following document aims to offer practical guidance to land managers, developers and asset managers/operators, in implementing nature-positive management practices across renewable energy sites. While focusing on solar sites, the blueprint is applicable across various asset types including wind, forestry, pumped-storage hydro, and more.

As the UK Government emphasises support for increased natural capital and renewables, initiatives like this become increasingly vital, offering opportunities to address the intertwined crises of climate change, biodiversity loss, and land degradation.



Fordie Estate, Scotland, part of Foresight Sustainable Forestry Company Plc's portfolio

Aim of the Blueprint

The purpose of this document to help guide land managers, developers, asset managers and operators to implement nature positive management practices that benefit all stakeholders, by:

- Defining and demonstrating the role of business in supporting nature recovery
- Giving greater visibility and access to existing nature positive initiatives currently being conducted nationwide
- Suggesting actions that will support nature recovery above and below ground, contribute to biodiversity and climate targets locally and nationally through:
  - Identification of methodologies for monitoring, measuring and evaluating biodiversity
  - Identification of transformative actions that will create opportunities to restore and improve nature
  - Recommending actions which do not compromise the generation of renewable electricity
- Providing places for positive nature connection for local communities

How to use this Blueprint

This document is to be used as a 'how to guide' for the UK solar industry to monitor, manage and implement biodiversity actions. These actions are not a one size fits all approach. Although there are common features present on solar sites they are also complex. Where the recommendations may not be suitable for all solar sites, the actions have been designed to accommodate some of the barriers more commonly found on solar sites in the UK.

The document provides a variety of options for land managers, developers, asset managers and operators to implement. Each option presents an action, the associated impact, the approximate costs and the months in which the actions can be undertaken. These calendars are designed in line with the ecological calendar, such as aligning cutting on sites to maximise wildflower growth aiding the pollinator population.

The document does not need to be read in sequence and is designed for a pick and choose approach to biodiversity positive solutions. Relevant solutions and actions can be easily navigated by the table of contents. Although the document has been produced to adhere to the restrictions on solar farms the actions can also be implemented on different types of sites.

> **60% of the 3,146**
> species monitored being recorded as declining over the past 50 years.
>
> https://stateofnature.org.uk/ as of 2023

Acknowledgments:

The Blueprint highlights the collaborative efforts of Foresight and the Eden Project. The expertise shared encompasses various aspects essential for ecological assessment and environmental management, providing valuable insights for sustainable practices drawing from the Eden Project's ecology team's understanding of:

- The EclA process
- Ecological features
- Habitat associations and preferences
- Conservation status and distribution
- Legal protection
- Survey techniques
- Vulnerability to impacts
- Measures to avoid, mitigate, compensate, and enhance biodiversity

Where useful, further references have been provided drawing on relevant wider industry research and practice.

We would like to acknowledge and thank the contributors to this project:

- Principal contributor, Stephanie Knights (BSc Hons), National Wildflower Centre Manager, Eden Project
- Sophie Warren MIEMA CEnv, Portfolio Sustainability Manager, Foresight
- Tom Taylor, UK Solar Operations (Asset Management) Lead, Foresight
- Henry Morgan, Sustainable Investment Associate Director, Foresight
- Lily Billings CEnv MIEMA, Director and Head of Group Sustainability, Foresight
- Juliet Rose, Head of Development, Eden Project
- Dan James, Development Director, Eden Project
- Lorna Lyle, Founder of Earth Energy Education

Southern Marsh Orchid

2. Baselining

In this section:

Introduction to baselining

Whether establishing a new solar site or enhancing an existing one for nature, it is recommended that an ecological baseline is carried out at the site to better understand the condition of existing habitats that support biodiversity.

All baselining frameworks track the key characteristics of biodiversity, which are; species richness, abundance of species, vulnerability of ecosystems, functionality and integrity.

A strong baseline can be built by gathering the following information through a series of surveys:

- Identification of existing and priority habitats present on site
- Areas that these habitats cover
- A habitat condition assessment to determine the quality of existing habitats
- BNG metric calculation to evaluate current and potential habitat unit value[1]
- Wildlife surveys to identify species present on site, such as breeding birds and protected species (e.g. bats, dormouse)
- Soil composition analysis to assess soil health

This information, alongside local biodiversity records and landscape maps, can be used to:

a. Determine if habitat improvements need to be made on site to better support wildlife

b. Identify habitat enhancement interventions to improve existing habitat for biodiversity and connectivity to the wider landscape

c. Recommendations for mitigating habitat loss when establishing a site

There are several options available to obtain an ecological baseline of a site, which will vary depending on budget and the aim of the survey.

An ecological baseline survey can vary from basic botanical and bird surveys to a Preliminary Ecological Appraisal (PEA), UK Habitat Classification (UKHab) and The Statutory Biodiversity Metric: Condition Assessment. These are outlined in the tables below.

1. This can also help you anticipate financial returns from biodiversity investment, such as tradeable units generated from Biodiversity Net Gain (BNG). An explanation on BNG is given further in this section.

Disclaimer

In the following sections you will find seasonal recommendations for delivery of each option. These are provided as indicative only and will be subject to climatic conditions, regional topography and local geography.

Wildflower Seed Collection at Fordie Estate, Scotland, part of Foresight Sustainable Forestry Company Plc's portfolio

Preliminary Ecological Appraisal

One way of gathering ecological baseline information about a site is to commission a Preliminary Ecological Appraisal (PEA). This is a standardised method for surveying habitats and biodiversity on a site to obtain an ecological baseline. It should be conducted by a suitably qualified field ecologist as stated in the guidelines set by the Charted Institute of Ecology and Environmental Management (CIEEM, 2017)[1].

Typically, a survey will include a desktop survey, site visit, Phase 1 survey and written report. More recently, ecologists have been converting to the UKHab Survey. It is considered best practice to conduct a PEA on sites that are going to be developed or require assessment for potential to support locally prominent and/or protected species.

A PEA has three main elements:

Stage	PEA survey/baseline type	Aims
1	**Ecological desk study**	The desktop study is undertaken to gather any existing data on surrounding designated sites, current and historical land use, priority habitats, landscape connectivity, soil composition and species of conservation concern present from within and around the site. Records should be requested from a local environmental records centre to obtain lists of habitats and species of principal importance for the conservation of biodiversity[2].
2 a)	**On-site habitat survey – Phase 1 survey/UKHab**	A Phase 1 survey or UKHab: • Provides a map of the habitats present on a site and a description of each habitat, including a plant species list (with invasive non-native species, if present). Each habitat is assessed for its potential to support protected and priority species. Fauna observed during the survey are also recorded • Identifies ecological constraints and features of biodiversity value • Informs design of interventions that help minimise or avoid impacts on biodiversity • Identify specific issues such as likely presence of protected or priority species, further surveys are likely to be recommended • Inform the scope of any necessary further ecological surveys and assessments and identify opportunities for ecological enhancement
2 b)	**On-site habitat survey (additional surveys) – Extended Phase 1 (e.g. for development purposes) or protected species surveys**	Further surveys may identify that priority habitat and/or species are present and facilitate a more detailed assessment of the legal and potential impacts on protected species (e.g. hazel dormouse).
3	**Preliminary Ecological Appraisal Report (PEAR)**	The findings from the PEA and any further on-site surveys will be documented in a written report. The report should include a summary of the following: • Summary of the site including site map • Habitats and biodiversity features present on site (habitat map, habitat size, photos) • Protected species identified • Recommendations for further surveys, management methods and enhancement opportunities

1. CIEEM PEA guideline https://cieem.net/wp-content/uploads/2019/02/Guidelines-for-Preliminary-Ecological-Appraisal-Jan2018-1.pdf.
2. Example of local environmental records centre – Environmental Records Centre for Cornwall & The Isles of Scilly https://erccis.org.uk/.

Preliminary Ecological Appraisal continued

Preliminary Ecological Appraisal (PEA) or ecological baseline survey

Action	Impact	Approx. cost (/MW,/ha, etc.)
PEA or baseline survey should be conducted by a suitably qualified ecologist from a reputable ecology consultancy. **The report includes a desktop study, site walkover, Phase 1/UKHab survey, habitat map and report. This can be undertaken at any time of the year; however, the season will have an impact on botanical surveys and potential presence/absence of certain protected species.** **Optimal survey season is spring/summer. Enquire with a reputable ecology consultancy for a quote.**	Provides an overview of existing habitats on a site, identifies features of ecological value (e.g. priority habitat) and potential to support protected species, connectivity to the wider landscape, any concerns (e.g. signs of degradation, run-off etc.) and provides recommendations for further surveys and management methods.	**£750 to £5,000+ depending on size of site and findings**

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The UKHab Classification System

Shotwick solar site

The UKHab Classification System is a tool used to classify a habitat type by identifying the plant communities present within an area. UKHab can be applied to baseline and monitor different types of habitats and provides data that can be used to measure environmental impact, inform the mitigation hierarchy and plan for Biodiversity Net Gain.

The latest version of the UKHab System was published by Natural England in March 2023, pooling contributions from the Environment Agency and Forestry Commission. The primary goal of UKHab is to standardise habitat classification and data. Consistency across surveying, monitoring and action is key for all stakeholders involved in nature recovery. Without it there cannot be an aligned understanding of impact or solution.

When baselining a given site, not only is it important to know what type of habitats there are, but also what condition they are in as this directly correlates to the biodiversity value of a site. Habitat condition is measured against its ecological optimum using a set of condition assessment criteria outlined in The Statutory Biodiversity Metric: Condition Assessment.

The Statutory Biodiversity Metric is designed to complement the UKHab classification system. To find out more about UK Biodiversity Net Gain processes and procedures visit the government website: https://www.gov.uk/government/collections/biodiversity-net-gain

The Statutory Biodiversity Metric (DEFRA)

Baseline information is essential if you want to calculate the potential Biodiversity Net Gain potential of your land. Under the Environment Act 2021, all planning permissions granted in England (with a few exemptions) will have to deliver at least 10% Biodiversity Net Gain (measured in Biodiversity Units) from February 2024. This could present an opportunity to incentivise nature recovery on any land that is able to deliver such improvements.

What is a Biodiversity Unit?

To deliver Biodiversity Net Gain (BNG) the UK Government has created a specific metric to calculate the value or number of Biodiversity Units that can be generated by creating or enhancing habitats from a range of baseline conditions. This is determined through the aforementioned UKHab (habitat classification) system and standard ecological assessment processes.

Biodiversity Units:

- Give a biodiversity value to an area of land
- Demonstrate biodiversity gain or loss over time
- Allow comparison between different proposals for a site and predict the effectiveness of different interventions
- Enable assessment of different impacts

Not all developers will be able to achieve Biodiversity Net Gain within their sites stipulated boundary, so the Environment Act provides for the possibility of purchasing Biodiversity Units through offset i.e. the provision of biodiversity gain on a different site.

The current estimated cost of a Biodiversity Unit will vary depending on availability and location. However, the UK Government has stipulated statutory prices developers will be required to pay if they are unable to either deliver BNG on their own sites or source BNG units from elsewhere. These statutory prices range from £42,000 to £650,000 for a single unit, dependent on the type of unit required. The value associated with the creation of Biodiversity Units may help landowners, land managers and developers design, plan and enact land management decisions that take better account of biodiversity. The resultant units can then be bought or sold through private agreement or even habitat banks.

The Statutory Biodiversity Metric

The Biodiversity Metric calculates the change in biodiversity that results from a project or development by subtracting the baseline or 'pre-intervention' units (e.g. those originally existing on or off site) from 'post-intervention' units (e.g. those projected to be provided after the development or change in land management).

The Statutory Biodiversity Metric uses habitats to evaluate biodiversity. These habitats are converted into Biodiversity Units and are the currency of the metric.

Biodiversity Units are calculated using:

1. The **size** of a parcel of habitat and its quality.
    - Size is determined by hectares except for linear habitats that are measured in kilometres
2. The **quality** of a habitat such as:
    - **Distinctiveness** – habitats that are rare or scarce typically score highly relative to habitats that are more common and widespread
    - **Condition** – habitat condition is measured against its ecological optimum using a set of condition assessment criteria based on habitat features and plant communities, which vary depending on habitat type
    - **Strategic significance** – whether it forms part of a nature recovery network or other local strategy
3. **Difficulty or risk** of creation or enhancement including time to target condition and spatial risk.

The Statutory Biodiversity Metric (DEFRA) continued

What is a Biodiversity Unit? continued

BNG condition assessment and BNG Metric calculations[1]

Action	Impact	Approx. cost (/MW,/ha, etc.)
Information obtained from the UKHab Survey will be used to determine a habitat baseline type. **After baseline habitat types have been identified on a site, they will be assessed and scored for quality (Poor, Moderate or Good) using the Statutory Biodiversity Metric: Condition Assessment. The condition of the habitat is determined against a set of criteria based on optimal habitat features and indicator species for that habitat type.** **Data from the UKHab survey and condition assessment is entered into the Statutory Biodiversity Metric calculator tool to obtain a biodiversity unit value for the baseline habitat, and post enhancement or creation habitat, which should be of equal or better quality.**	The Statutory Biodiversity Metric can be used to evaluate land for BNG purposes and generate a biodiversity value for habitats present, enhanced or created on site. This can be used to incentivise nature recovery on solar farms for a minimum of 30 years.	**£500 to £5,000+ depending on size of site, findings and surveys**

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1. https://www.gov.uk/government/publications/statutory-biodiversity-metric-tools-and-guides

Soil baselining

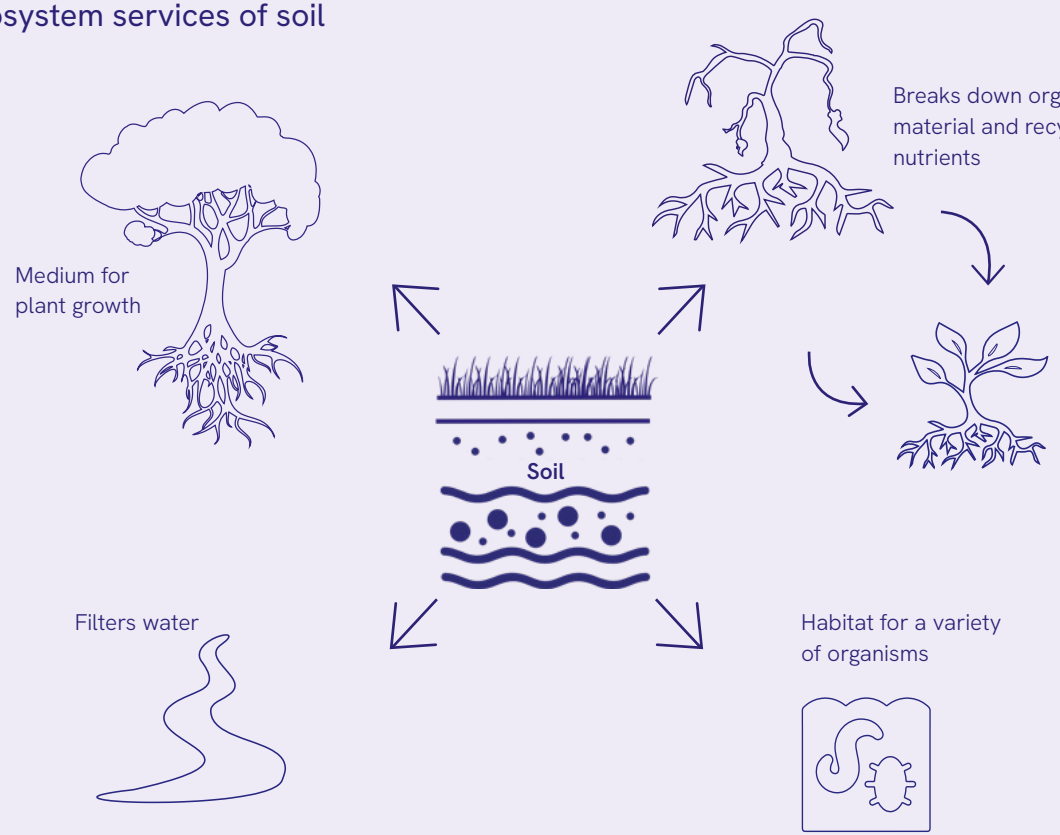
The importance of healthy soils

Soils provide many essential ecosystem services to both people and the planet. Soils give us food, purify our water, break down pollutants, protect us against flooding, retain moisture to combat drought and capture and store vast amounts of carbon.

Healthy soils contain organic matter, which is teeming with life. A teaspoon of healthy soil can contain more organisms than there are people on the planet![1] Organic matter makes up just 2–10% of most soil's mass, but has an important role in the physical, chemical and biological function of soils. It stores more than three times the amount of CO_2 compared to the air, forests and other vegetation.

However, soil health is under threat on a global scale. It is estimated that 66%[2] of soils globally are moderately or highly degraded. This is largely due to contamination and erosion caused by intensive farming practices, poor land management, climate change, deforestation and development. According to the UN's Food and Agriculture Organization[3], we only have 60 years of topsoil left to farm if we continue at the current rate of degradation. The clock is ticking for us to act.

Ecosystem services of soil



1. Soil Association https://www.soilassociation.org/media/6263/living-soils-a-call-to-action-2015.pdf.
2. Food and Agricultural Organization of the United Nations: Status of the World's Soils Resources https://www.fao.org/3/i5199e/i5199e.pdf.
3. UN Food and Agriculture Organization soil degradation https://www.sej.org/headlines/only-60-years-farming-left-if-soil-degradation-continue.

Soil baselining continued

Assessing soil health

The colour, texture and smell of soil can tell us a lot about soil type and health. For example, sandy soils drain freely and lose nutrients more quickly, whereas clay soils hold onto moisture and retain nutrients more easily.

The presence of blue-grey colours in clay soils is an indication that the soil has been starved of oxygen. Badly drained soil might also smell of rotten eggs. Poor quality soil cannot provide vital nutrients and minerals for plants to grow or support biotic life, both essential for a healthy ecosystem.

Alongside a visual assessment of soil, laboratory soil tests[1] can tell us how fertile soils are, their chemical composition and how much soil carbon is present. These assessments can further help us determine what the soil needs to recover and/or what plants and seed mixes are best suited to a particular soil type.

Soil resources report

Action	Impact	Approx. cost (/MW,/ha, etc.)
Undertake a soil resources survey to assess and map the current extent and condition of soils at each site. This requires taking up to six soil samples per habitat at a max. of 30cm in depth. The Farm Carbon Toolkit[2] provides a sampling protocol that is easy to follow. Sampling can be outsourced to a qualified agronomist if there is budget for it. Samples should be sent to an accredited soil lab for a minimum of pH, potassium (K), phosphorous (P), magnesium (Mg) analysis. Sampling can be repeated every three years to monitor for changes in soil health.	The soil analysis will provide valuable information about the chemical, physical and biological status of the soil, and will help determine suitable nature-based solutions, remediation and/or wildflower mix for the target habitat being created or enhanced.	**From £32 per sample analysis – LOW COST**

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1. UKAS accredited soil analysis laboratory https://cawood.co.uk/nrm/.
2. Monitoring-Soil-Carbon-a-practical-field-farm-and-lab-guide-Low-Res-Version.pdf (farmcarbontoolkit.org.uk).

Soil baselining continued

Assessing soil health continued

Example of soil analysis report

Laboratory sample reference	Field Details			Index			mg/l (Available)		
	No.	Name or O.S. Reference with Cropping Details	Soil pH	P	K	Mg	P	K	Mg
17097/22	1	**G WESTERN G 18TM** Other Crop into Other Crop	7.7	2	1	2	15.8	92	91
17098/22	2	**G WESTERN G 2TOP** Other Crop into Other Crop	7.8	1	1	2	12.4	61	97
17099/22	3	**NIKS FIELD H** Other Crop into Other Crop	6.2	3	1	3	30.2	94	110
17100/22	4	**TONKIN B** Perm Pasture into Other Crop	5.9	2	0	2	17.8	57	75
17101/22	5	**TONKIN C** Perm Pasture into Other Crop	5.8	0	1	2	9.4	61	55
17102/22	6	**OVERFLOWCARPARKD** Other Crop into Other Crop	7.5	0	0	2	8.2	56	64

Soil baselining continued

Assessing soil health continued

Soil organic carbon (SOC) – C sequestration sampling

Action	Impact	Approx. cost (/MW,/ha, etc.)
Soil organic carbon (SOC) is a measurable component of soil organic matter (SOM), usually accounting for around 60% of the dry mass of SOM. SOC can be measured at each site to obtain a baseline or prior to establishing habitats. Soil bulk density varies by soil type and management, to calculate the mass of carbon you need to know the soil bulk density. To produce a composite soil sample, five to 10 soil samples should be taken within each habitat to a depth of 1cm to 15cm (max. 30cm). Samples should be taken using a consistent methodology and at the same time of year, as SOC can vary depending on the season. Samples should be sent to an accredited soil lab for bulk density testing. It is usually best to sample in spring or autumn.	Measuring SOC offers insight into how much carbon is captured, the quality of the soil carbon and how to improve the soil carbon content. Sequestering carbon in SOC has been suggested as one way to mitigate climate change by reducing atmospheric carbon dioxide. Measuring the organic carbon content of soils prior to establishing habitats will provide us with baseline data to work from. Calculating carbon credits through measuring SOC can help you prove and claim sustainability for your site.	**From £20 per sample – LOW COST**

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Soil baselining continued

Assessing soil health continued

Visual evaluation of soil structure (VESS) check

Action	Impact	Approx. cost (/MW,/ha, etc.)
The VESS test (original guidelines developed by SRUC[1]) assesses soil structure based on the appearance and feel of soil dug out with a spade. In this test you observe and record how aggregated the soil structure is (aggregation is the crumb structure that naturally occurs in healthy soil). You can do this very easily by simply pushing a spade vertically into the soil and digging out a spade-full to a depth of about 25-30cm. This can be done at any time of year, but ideally when the soil is moist. Using your hands, you can break the soil block up, if it breaks up easily into small fragments, then the structure is likely to be good. The VESS scoring[2] scale ranges from 1 – very good structure to 5 – poor structure. For each spade-full you are encouraged to do two VESS readings, one for the top layer of soil, and another for the soil below, as well as measure the depth of each. Usually the top layer scores better, and as the soil improves over time the top layer will get deeper, so it's important to record top depth.	Soil texture and structure affects root penetration, water availability to plants and soil aeration. A VESS test is ideally suited to evaluate and monitor soil degradation in remote and undeveloped areas.	**O&M operatives can follow simple free instructions to do this themselves – NO COST**

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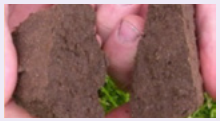
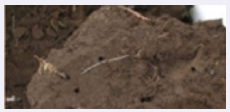
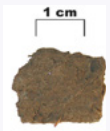
1. VESS guidance doc by SRUC: https://www.sruc.ac.uk/media/ki2n30aj/vess-method-description.pdf.
2. VESS score chart: https://soils.vidacycle.com/wp-content/uploads/2019/08/VESS_score_chart.pdf.

Soil baselining continued

Assessing soil health continued

Measuring soil organic matter

Structure	Size and appearance of aggregates	Visible porosity and roots	Appearance after break-up: various soils[1]	Appearance after break-up: same soil different tillage	Features	Appearance and description of natural or reduced fragment of ~1.5cm diameter
SAMPLE 1 Aggregates readily crumble with fingers	Mostly <6mm after crumbling.	Highly porous. Roots throughout the soil.			 Fine aggregates	 The action of breaking the block is enough to reveal them. Large aggregates are composed of smaller ones, held by roots.
SAMPLE 2 Aggregates easy to break with one hand	A mixture of porous, rounded aggregates from 2mm – 7cm. No clods present.	Most aggregates are porous. Roots throughout the soil.			 High aggregate porosity	 Aggregates when obtained are rounded, very fragile, crumble very easily and are highly porous.
SAMPLE 3 Most aggregates break with one hand	A mixture of porous, rounded aggregates from 2mm – 10cm; less than 30% are <1cm. Some angular, non-porous aggregates (clods) may be present.	Macropores and cracks present. Porosity and roots both within aggregates.			 Low aggregate porosity	 Aggregate fragments are fairly easy to obtain. They have few visible pores and are rounded. Roots usually grow through the aggregates
SAMPLE 4 Requires considerable effort to break aggregates with one hand	Mostly large >10cm and sub-porous; horizontal/platy also possible; less than 30% are <7cm.	Few macropores and cracks. All roots are clustered in macropores and around aggregates.			 Distinct macropores	 Aggregate fragments are easy to obtain when soil is wet, in cube shapes which are very sharp-edged and show cracks internally.
SAMPLE 5 Difficult to break up	Mostly large >10cm, very few <7cm, angular and non-porous.	Very low porosity. Macropores may be present. May contain anaerobic zones. Few roots, if any, and restricted to cracks			 Grey-blue colour	 Aggregate fragments are easy to obtain when soil is wet, although considerable force may be needed. No pores or cracks are usually visible.

1. VESS Guidance doc by SRUC: https://www.sruc.ac.uk/media/ki2n30aj/vess-method-description.pdf.

Soil baselining continued

Estimate the Ellenberg values of above ground vegetation.

Ellenberg values can be a quick way to assess the soil conditions of your site. Plants rely on various common environmental factors, such as light, temperature, continentality (climatic temperature changes), moisture, soil pH, nitrogen and salinity. These environmental factors are fundamental to plant survival, health and optimal growth. External pressures, such as predation, competition, resource location and other abiotic influences (non-living e.g. wind, rainfall), also influence plant success.

It is possible to make assumptions about the ecological conditions and soil relating to a site from the plants present on it. Wildflowers are a good indicator of such conditions. For example, if you find meadow buttercup (*Ranunculus acris*) in grassland it is a good indication that it is a sunny location, soil conditions are moist, but well-drained, slightly acidic and infertile. In contrast, red campion (*Silene dioica*) prefers a partially shady spot and slightly acidic, but more fertile soils. Whereas foxglove (*Digitalis purpurea*) like full sun and thrive in dry conditions with moderately fertile, acidic soils (see Table 2 of related Ellenberg values for these wildflower species).

Ellenberg values are indices given to each species of plant to express the species' environmental preferences. They are simple values given on a 10-grade scale (0-9), apart from light, temperature and soil moisture, expressed on a 0–12 scale and salinity on a 0–3 scale. They can be used at a site to estimate environmental (chemical and physical) conditions and to monitor changes of key parameters over time. The table opposite gives an illustration of some indicator values for various environmental factors.

Ellenberg values

Table 1. An example of Ellenberg values for light, moisture, nitrogen and pH have been provided for three common wildflower species, foxglove, meadow buttercup and red campion, in the table below:

Environmental factor	Symbol	Indicator value, in the sense of "the species prefer..."
Light value	L	1 = deep shade, 5 = semi-shade, 9 = full light
Temperature value	T	1 = alpine-subnival, 5 = submontane-temperate, 9 = Mediterranean
Continentality value	K	1 = euoceanic, 5 = intermediate, 9 = eucontinental
Moisture value	F	1 = strong soil dryness, 5 = moist, 9 = wet, 10 = aquatic, 12 = underwater
Reaction of soil value (pH)	R	1 = extremely acidic, 5 = mildly acidic, 9 = alkaline
Nitrogen value	N	1 = least, 5 = average, 9 = excessive supply
Salinity value	S	0 = no, 1 = weak, 5 = average, 9 = extreme salinity

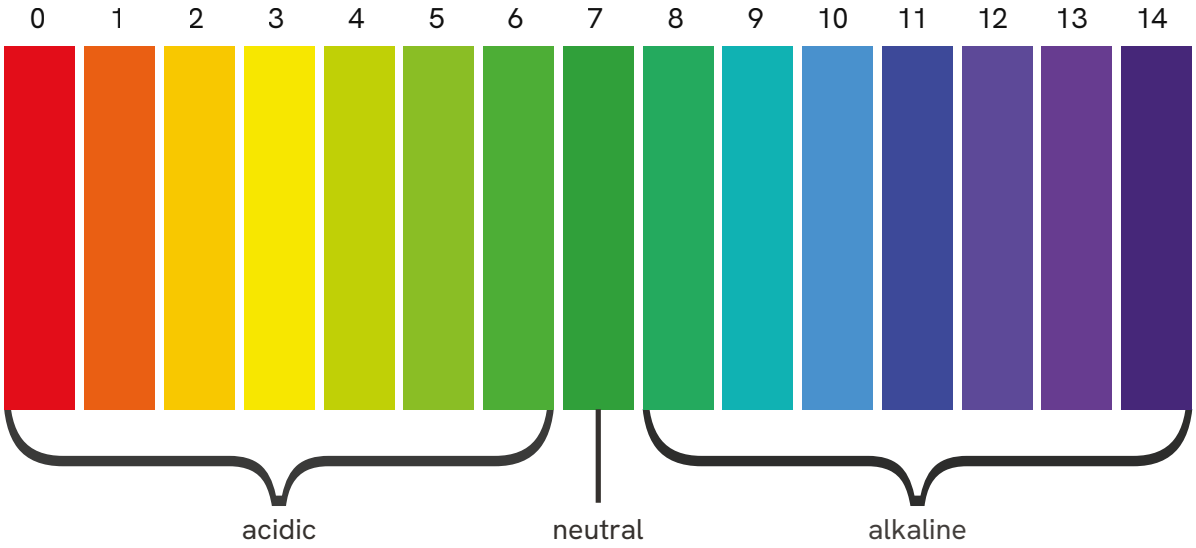
Table 2. Ellenberg values for wildflowers examples: foxglove, meadow buttercup and red campion

Species	Light	Moisture	Nitrogen	pH	Interpretation
Foxglove, *Digitalis purpurea*	6	6	5	4	Prefer full sun but will tolerate partial shade. Does not like very wet or dry conditions, somewhere in between is optimal. Acidic and moderately fertile soil is optimal, but will tolerate fluctuations in pH and less fertile soils.
Meadow buttercup, *Ranunculus acris*	7	6	4	6	Prefers full sun but will tolerate partial shade. Prefers slightly acidic, slightly infertile soils that are moist, but well-drained. Tolerant of slight fluctuations in pH.
Nitrogen value	5	6	7	6	Prefers partial shade but tolerant of full sun. Neutral and fertile soils that are moist, but well-drained are optimal. Dislikes waterlogging.

(Ellenberg et al. 1991) Ellenberg, H., Düll, R., Wirth, V., Werner, W. & Paulißen, D. (1991) Zeigerwerte von Pflanzen in Mitteleuropa, 2nd edn. Verlag Erich Goltze KG, Göttingen. Scripta Geobotanica. Landlife (1997). Wildflowers Work: a technical guide to creating and managing wildflower landscapes. Liverpool: Landlife.

Soil baselining continued

pH indicator scale



Example of Woodland with Bluebells

Soil baselining continued

Example values of soil organic carbon on different management regimes

It is common knowledge that forests have the ability to sequester carbon, removing it from the atmosphere and storing it in their biomass, leaves and soil. Northern boreal forests hold the greatest stores of carbon per hectare, with a high proportion (84%) held in the soil, while tropical forests store more carbon than temperate forests with 50% in biomass. However, when trees are harvested or destroyed through fire, carbon is released back into the atmosphere[1].

Grasslands also sequester carbon, but at a lower rate than forests. However, most of the carbon is stored reliably and safely in the soil. Temperate grasslands are notable for being the largest store of soil carbon, with 97% stored in the soil. The carbon stored per hectare is 25% greater in extensive grassland (meadows and pastures) than intensive grassland (agricultural)[2].

Grasslands in the UK sequester 200 billion tonnes of carbon[3], which means they have huge potential for carbon storage. The plants and their relationships with below ground fungi, bacteria and many other species help enrich the soil with carbon.

Soil carbon sequestration is a benefit likely to arise from the low level of management of a solar farm managed for biodiversity[4]. This could be achieved through a move towards permanent pasture with areas of rough grassland and the implementation of biodiversity enhancement activities, such as increasing plant diversity through the introduction of wildflowers. The combined value of woodlands and grassland is key, either in dedicated separate areas or integrated systems, such as wood-pasture.

A soil risk assessment and soil management plan may be appropriate when you are planning a new solar site to ensure you are handling soil correctly, not jeopardising soil health or creating soil problems or affecting the future success of other opportunities on site e.g. agrivoltaics. A soil management plan template can be found here: Soil Management Plan – Red Tractor Assurance.

For best practice guidance on materials management, consult the Construction Code of Practice for the Sustainable Use of Soils on Construction Sites[5]. Should further advice on soil management be required, consult an agronomist or environmental advisor with a BASIS Soil and Water Management qualification. A register of BASIS advisors can be found at https://www.basis-reg.co.uk/environmental-advisers/welcome.

Soil management plan

Action	Impact	Approx. cost (/MW,/ha, etc.)
Create a soil management plan to balance the inevitable short-term release of carbon accompanying a change in land use, with the potential for longer-term sequestration that varies by habitat type.	Guides the sustainable management of soils for carbon sequestration and improved resilience to environmental change.	**£100 to £500+ depending on scale – LOW COST**

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1. CABI https://blog.cabi.org/2020/06/25/the-climate-battleground-grassland-or-forest/.
2. Ward et al., 2016. Legacy effects of grassland management on soil carbon to depth. Global Change Biology. Volume 22. Issue 8. August 2016. Pages 2929-2938 https://onlinelibrary.wiley.com/doi/10.1111/gcb.13246.
3. Grassland carbon statistic: https://www.wildlifetrusts.org/habitats/grassland.
4. Solar Energy UK (2022a). Natural Capital Bes Practice Guidance – Increasing biodiversity at all stages of a solar farm's lifecycle. London: Solar Trade Association.
5. Construction Code of Practice for the Sustainable Use of Soils on Construction Sites: pb13298-code-of-practice-090910.pdf.

Ongoing monitoring and surveying plans

Effective monitoring of sites allows site managers to measure the impact of different interventions and management regimes, gauge the general health of habitats on a site that will be subject to external pressures and provide information to help plan for the future by revealing opportunities or challenges.

Monitoring recommendations are modified from Solar Energy UK (2022b)[1] with Table 3 listing key components to be monitored and Table 4 recommending additional components dependent on budget and the specific focus of biodiversity enhancements.

To minimise discrepancies in monitoring data over time, surveyors should be at least competent against the competency framework produced by the Chartered institute for Ecology and Environmental Management (CIEEM). Botanical surveyors can also demonstrate competence through achieving a Field Identification Skills (FISC) Level 4 or above.

UKHab surveys are compatible with The Statutory Biodiversity Metric, hence they are recommended for future surveys on solar sites and where comparisons to other sites required to use this monitoring framework are intended.

Solar farms can present challenges to botanical survey methodology and whilst Solar Energy UK currently recommend the use of fixed-point quadrats for monitoring, they may not provide representative data, particularly given the sampling intensity required at larger sites. An alternative approach to discuss with ecologists contracted for ongoing monitoring is the use of a relevé approach, where plant community types are described within sufficiently sized plots located within different habitat types, and to allow comparison of areas within control (business as usual) vs enhancement activities.

Table 3. Key components to monitor. Modified from Solar Energy UK (2022b)

Component	Description	Time required and frequency	Further considerations
Site information	Information on current and past management, seeding and planting undertaken as well as future plans in terms of changes to management.	Time required: can take time to obtain this information. To be recorded during every visit.	
Standard survey data	Including name of surveyor(s), date, weather, time spent on site.	Time required: minimal. To be recorded during every visit.	
Site management	Site management categories have been devised to produce a standard summary which is comparable between sites: 1. Optimal management for wildlife with conservation cutting/grazing applied and no herbicide use. Arisings are removed from the site. Diversity of habitats (e.g. meadows, tussocky grassland, woodland planting, hedgerow planting). 2. Conservation cutting/grazing applied. Arisings left on the site with signs of a thatch of vegetation in places. Diversity of habitats (e.g. meadows, tussocky grassland, woodland planting, hedgerow planting). Herbicides may be used, but spot treatment only.	Time required: minimal. To be recorded during every visit.	This data may be obtained at an early stage from the O&M company or asset owner. However, where this information cannot be obtained, management may need to be ascertained from the survey (i.e. evidence of grazing, height of vegetation, evidence of spraying, etc.).

1. Solar Energy UK (2022b). A standardised approach to monitoring biodiversity on solar farms. London: Solar Trade Association.

Ongoing monitoring and surveying plans continued

Table 3. Key components to monitor. Modified from Solar Energy UK (2022b) continued

Component	Description	Time required and frequency	Further considerations
Site management continued	3. Site cut or grazed throughout the season leading to short sward in the summer months. However, some other habitats present, such as tussocky margins or planted hedgerows/woodland. Use of herbicides apparent (i.e. blanket spraying beneath panels). 4. Site cut or grazed throughout the season leading to short sward in the summer months. No other habitats (tussocky margins, new hedgerows/ woodland). Use of herbicides apparent (i.e. blanket spraying of fields or beneath panels). 5. Site unmanaged or "other".	Time required: minimal. To be recorded during every visit.	
UKHab survey	Mapping of all habitats within the redline boundary using the UKHab categories. These can then be used to calculate Biodiversity Net Gain if required.	Time required: several days given the size of the site at Sandridge. Should be repeated every five years.	Where beneath panel habitat is distinct and requires separate mapping, a calculation of area may be made from the number of panels on the site (a figure usually included within the site layout plan). Best carried out April to October inclusive.
Standard botanical quadrats	• Eight quadrats recorded directly beneath panels • Eight quadrats recorded in the open, between the strings of panels • Eight quadrats recorded in "enhanced" area – selected as the most diverse habitat within the redline/lease boundary. Habitat category recorded: field margin (within security fencing); field margin (outside security fencing); easement area; ground nesting bird area and other • Eight quadrats recorded within a control site – a field within the same landowners holding, which is managed in the same way the land within the array was prior to construction 2mx2m quadrats at fixed locations The % cover of all species within the quadrat will be recorded. Other information to record includes: height of sward in cm and % cover of bare ground, dead thatch and standing water (where applicable).	Time required: approx. three to five hours. To be recorded during every visit.	Given the size of the site and presence of distinct habitats, the number of quadrats recommended here is twice that stipulated in industry guidance. Fixed locations can be marked through flagging legs of panel frames or security fencing (with flagging/ cable ties etc.). Strings may also be numbered which can aid with locating quadrat positions. Best carried out April to August inclusive.

Ongoing monitoring and surveying plans continued

Table 3. Key components to monitor. Modified from Solar Energy UK (2022b) continued

Component	Description	Time required and frequency	Further considerations
Nectar production potential	Use the botanical quadrats to infer nectar production potential using established data.	Minimal time required. Should be repeated with every botanical survey.	Baude et al (2015) provides a data set of nectar sugar values of common British plant species and can be used to calculate nectar production potential.
Basic soil survey	Basic agricultural soil properties (pH, soil type, soil organic matter, soil moisture, nitrogen phosphorus, potassium and magnesium). The methodology for soil collection should be checked with the laboratory but will likely follow the standard collection method for agricultural analysis. We would suggest taking samples from one field within the array within a 4 ha area (further fields can be included as separate samples). In addition, samples can be taken from a field outside the array which is managed in the same way that the array was prior to construction, as a control.	Time required: one to three hours to collect samples. Should be repeated every five years.	Soil can be collected on site and sent to a laboratory. A basic measure of soil carbon can also be obtained from the organic matter measurement (organic matter divided by 1.72). Soil analyses can also help to inform seeding of a site and indicate why seeding may have failed. Can be carried out at any time of the year.
Fixed-point photos	A number of fixed-point photographs can be a simple way to visually assess change.	Minimal time required. To be recorded during every visit.	The simplest way to approach this is to take a photo from each quadrat location and record the orientation. Photos can also be taken of the vegetation within the quadrats, and soils beneath (spade sample).
Ad hoc sightings	Observations of species are recorded during the time spent on site; this may include sightings of hares and other mammals, birds by song or sight, patches of wildflowers, badger latrines, owl pellets as well as invertebrates (a tally should be kept for butterflies and bumblebees).	Minimal time required. To be recorded during every visit.	Although not directly comparable, ad hoc sightings can give a qualitative picture of a site. Best carried out April to August inclusive.

Ongoing monitoring and surveying plans continued

Table 4. Additional components to consider when monitoring from Solar Energy UK (2022b)[1]

Component	Description	Time required and frequency	Further considerations
Wildflower scorecard	Completion of this scorecard is a useful way to categorise sites according to their focus on biodiversity and also track overall change on a site or identify areas where positive changes can be made to management or habitat provision.	Time required: approx. three to four hours. Should be updated every 35 years (or when management changes are made).	
SPIES tool assessment	Assessment of how management practices currently impact ecosystem services using an evidence-based tool. This can also be used to assess any proposed changes to management.	Time required: approx. 0.5 hours. Should be updated every three to five years (or when management changes are made).	Can be carried out at any time of the year.
Biodiversity Net Gain (BNG)	The Natural England Biodiversity Net Gain Metric (currently v4.0) can be used to compare data for the site pre-construction with the data collected during monitoring to assess changes in habitats and net gain achieved.	Time required: approx. two to four hours. Should be updated every three to five years (or when management changes are made).	Calculation of BNG during operation may be a requirement of any expansion /future development of the site requiring planning consent from November 2023.
Detailed soil analyses	More detailed analysis undertaken in the field, or some samples sent to a laboratory. This may include soil bulk density, soil infiltration capacity and soil organic carbon (SOC). Other specialist laboratories may be used to look at microbial/fungal communities. Analysis of eDNA can be used to explore changes in community composition whilst measuring soil respiration (CO_2 efflux) or enzyme activity can provide information on the activity of soil organisms.	Time required: one hour to collect samples. Should be repeated every five years.	Can be carried out at any time of the year but note that measures of microbial activity will vary with temperature, soil moisture content and season.
On and off-site water survey	Monitoring of basic water parameters in water features on site and any features off site that could be impacted by the solar farm. Use a handheld water quality measure to measure multiple parameters including temperature, dissolved oxygen, turbidity and conductivity.	Time required: approx. 15 minutes per water feature. Should be repeated every time on site given variability in measures.	Ensure the meter is calibrated. There is also potential to take samples and send for analyses for other parameters, such as nitrogen and phosphorous.
Pollinator survey butterfly and bumblebee transects	Butterfly and bumblebee transect surveys involve a surveyor walking a predetermined 100m transect route through the site and noting all butterflies and bumblebees within an imaginary 5mx5m quadrat in front of them. 10 transects spread across the site is usually suitable.	Time required: approx. two to three hours. Should be repeated every two to five years.	The survey does not require specialist ID skills and species can just be counted (i.e. “butterfly species 1”). The survey is weather dependent and needs to be carried out during warm, dry, still weather. Two to three visits in a single year would give best results. However, it can be done in a single visit if conditions are suitable. Can be carried out April to September inclusive; however, we suggest standardising to June/July.

1. https://solarenergyuk.org/wp-content/uploads/2022/06/Ecological-Monitoring-Guidance-2022.pdf

Ongoing monitoring and surveying plans continued

Table 4. Additional components to consider when monitoring from Solar Energy UK (2015)[1] continued

Component	Description	Time required and frequency	Further considerations
Breeding bird survey	Between two to six visits to the site conducted April to June and following recent bird survey guidelines (Bird Survey & Assessment Steering Group, 2021). The number of surveys will depend on the level of detail required.	Time required: approx. one to two hours per 15-20 ha per survey (although site dependent). Should be repeated every two to five years.	The survey should avoid heavy rain or strong wind. Specialist bird ID skills are required in order to identify birds by sight and sound. Can be carried out March to early July inclusive (and from half an hour before sunrise to 11.00am). If only two surveys conducted, it is best carried out April/May (weather dependent).
Wintering bird survey	Between two to three visits to the site conducted November to February to assess how birds utilise the solar farm and its boundaries over winter.	Time required: approx. one hour per 1,520 ha per survey (although site dependent). Should be repeated every 25 years.	The survey should avoid heavy rain or strong wind. Specialist bird ID skills are required in order to identify birds by sight and sound. Can be carried out November to February inclusive.
Other species-specific surveys	Other surveys may be included within the monitoring where there are known records, habitat is managed with a focus on that species or due to local conservation priorities/planning obligations. This may include: • Nocturnal/dusk bird surveys • Reptile surveys • Bat surveys (activity surveys or checks of roosts) • Amphibian surveys (including great crested newt) • Dormouse surveys • Harvest mouse surveys • Hedgehog surveys • Badger surveys • Otter/water vole surveys • Invertebrates • Earthworms surveys to assess grazing productivity such as above ground biomass or forage quality (above ground biomass calculation).		

1. https://solarenergyuk.org/wp-content/uploads/2022/06/Ecological-Monitoring-Guidance-2022.pdf

Protected species surveys

Protected species surveys are important because all wildlife in the UK is protected by law under the Wildlife and Countryside Act 1981[1]. This is an act prohibiting and limiting actions involving wild animals, and the primary piece of legislation for wildlife protection in the UK. It is an offence to take, injure, kill and disturb animals in the wild, and to disturb places used for shelter and protection. It also provides protections for wild bird nests and eggs.

Some species and subspecies of animals and plants receive extended protection under The Conservation of Habitats and Species Regulations 2017[2], this includes European Protected Species (EPS) and those listed in Annex IV(a), Annex II(b) (other than any bryophyte) or Annex IV(b) to the Habitats Directive. It is an offence to deliberately pick, collect, cut, uproot or destroy a wild plant of the species identified. Offences to wild animals includes: deliberately kill, injure, disturb or capture (take), transport, breed, sell or exchange any animal living or dead (or anything derived from) of these species identified.

Why are protected species important?

Protected species are recognised as 'flagship species', these species can heavily indicate the presence of other species, habitats and communities. Due to the suitability of their habitat for a wide range of other species, and ability to drive ecological processes, they are often seen as 'bioindicators'. This means that their presence can be used to measure habitat integrity, ecosystem health, and indicate the suitability of habitats for other sensitive species.

Should signs of protected species (e.g. excrement, nests) or suitable habitat for them be identified on a site, more detailed protected species surveys can be undertaken to confirm the likely presence or absence of a species, and identify important habitat features and population sizes. These surveys typically require repeat visits over a certain timescale[3]. Example of surveys for the following protected species listed below can be provided by a suitably licensed and qualified ecologist:

- Bat – roost inspection (tree and/or building), recording site emergence or re-entry, recording bat activity and backtracking
- Otter – recording otter activity and tracking
- Badger – identify location of setts and establish importance of each one and track activity
- Bird – breeding, nesting and wintering bird surveys (including owls)
- Hazel dormouse – nut hunts, nest tubes, natural nest searches
- Great crested newt – Stage 1: pond assessment of all ponds within 500m of the site (egg searches); Stage 2: HSI scores of ponds and habitat; and Stage 3: full survey to include trapping with four to six visits, and eDNA analysis
- Reptile – visual search of site looking for habitat, reptile refugia and signs of reptiles
- Water vole – assessment of riverbank and bodies of water, burrow and latrine searches, signs of feeding and droppings, and eDNA analysis

If there is evidence of protected or priority species present on site, special measures are required to protect them and their habitat from destruction and/or obstruction. The ecologist conducting the surveys will provide a full report with recommendations.

Protected species habitat surveys

Action	Impact	Approx. cost (/MW,/ha, etc.)
Undertake protected species surveys if evidence of protected species or suitable habitat can be identified on site. Contact a reputable ecology consultancy to discuss survey options, timeframe and costs. See the protected species seasonal survey calendar on the next page for guidance.	Protected species surveys will better inform the management of habitats on site and provide better protection to priority species and plants.	**£500 to £10,000+ depending on scale – MODERATE COST**

JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC

1. Wildlife and Countryside Act 1981: https://www.legislation.gov.uk/ukpga/1981/69.
2. The Conservation of Habitats and Species Regulations 2017 https://www.legislation.gov.uk/uksi/2017/1012/contents/made.
3. See protected species calendar for survey seasons.

Protected species surveys continued

Why are protected species important? continued

Protected species survey calendar

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	
				■	■	■	■	■	■				**Reptiles** Apr–Sep
					■	■	■	■	■				**Bats** May–Sep
				■	■	■	■	■	■	■			**Water Voles** Apr–Oct
	■	■	■	■	■	■	■	■	■	■	■	■	**Badgers** All year
				■	■	■							**Great Crested Newt** Apr–Jun
				■	■	■	■	■	■	■			**Dormouse** Apr-Oct
	■	■	■	■	■	■	■	■	■	■	■	■	**Otters** All year

Landscape and Ecological Management Plan (LEMP) review

A Landscape Ecological Management Plan (LEMP) is a site-specific document which provides instructions and processes for the planting and environmental management of a new development site.

The LEMP outlines immediate and long-term commitments provided to ensure the protection and enhancement of the ecology and biodiversity, in and around the site. Measures are set out in accordance with wildlife legislation, National Planning Policy Framework (NPPF) and other local plans and planning policies.

A review of the existing LEMP[1] is recommended to track progress and delivery on commitments established at implementation to present day. The review will also help to identify and inform areas for improvement on site.

Solar arrays

LEMP review

Action	Impact	Approx. cost (/MW,/ha, etc.)
Review LEMP and assess progress towards environmental commitments, management and compliance with wildlife legislation.	Establish what has been achieved so far, identify areas for improvement and opportunities for enhancement on site.	**NO COST**

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1. Example LEMP doc https://www.devon.gov.uk/planning/document/landscape-and-ecological-management-plans-lemps-version-1/.

Arboricultural (tree) surveys

Many sites have trees within their boundaries, sometimes as small copses as part of the overall site or within hedgerows. Arboricultural surveys should be undertaken regularly on sites where woodlands, stands or lines of trees are present. A tree survey is a specialist, technical report completed by a trained and competent arboriculturalist to determine tree health, safety of trees to people and assets, management and preservation of significant trees and shrubs.

Trees and woodlands considered of high amenity or nature conservation value, such as veteran trees, can be assessed for a Tree Preservation Order (TPO)[1]. A TPO prohibits a tree from being cut down, uprooted, damaged or destroyed without the local planning authority's written consent.

A tree can be assessed for a preservation order by a consultant; however, a TPO can only be issued and enforced by the council. Anyone who is found guilty and convicted of carrying out or giving permission for these offences can be liable to a fine of up to £20,000.

Visual Tree Assessment (VTA) and safety inspection

Action	Impact	Approx. cost (/MW,/ha, etc.)
Using the visual tree assessment (VTA) method, a tree safety survey and report will identify defects such as weak branch junctions or decay fungi which can affect the structural integrity of trees. All trees present on site should be inspected, but only details of those trees which are potentially hazardous are recorded within the tree report. This should be completed once every two years or if there is a known problem.	Identifies diseased and/or unsafe trees before they become a problem to site safety and tree health.	**From £199**

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Tree Preservation Order (TPO) assessment

Action	Impact	Approx. cost (/MW,/ha, etc.)
Assessment of individual trees and woodlands for amenity or conservation value for preservation under a TPO. Apply to the council for a TPO should trees for preservation be identified on site.	Trees of amenity or conservation value are protected in perpetuity from being uprooted, cut down or damaged, unless written consent is received from the council should the tree become diseased, pose a risk to human safety or assets.	**From £199**

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1. Tree Preservation Order (TPO) legislation: https://www.gov.uk/guidance/tree-preservation-orders-and-trees-in-conservation-areas.

Arboricultural (tree) surveys continued

Woodland survey/management plan

Action	Impact	Approx. cost (/MW,/ha, etc.)
On-site survey to record tree species present, number of trees, tree maturity and health. Management methods and practices can be recommended for wildlife.	Identifies better management practices of woodlands on site for wildlife and conservation purposes. Preserving woodlands and building resilience against climate change.	**From £199**

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Arboricultural impact assessment (BS5837 for development)

Action	Impact	Approx. cost (/MW,/ha, etc.)
An arboricultural impact assessment follows the recommendations of BS5837:2012 for development purposes and should be undertaken prior to planning submission and may be required by a planning application. A tree constraints plan, arboricultural impact assessments, tree protection plans and arboricultural method statements are provided following this assessment.	Tree surveys are required to collect the measured data which informs the development process. Tree constraints plans identify how the trees can affect your site layout.	**From £15,500**

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Asset manager-led surveys

If there is limited budget for the site in question, simplistic ongoing monitoring can be conducted by either the asset manager or the O&M service provider, even with limited knowledge of ecology.

Desktop survey

A desktop survey could include all or a few of the following:

Type of assessment	Identification method
Designated sites	• A review of previous site surveys or plans such as LEMPs • Use of the MAGIC Map tool[1]
Current and historical land use	• Identified in one of the following ways: – By the landowner – Planning documentation – Satellite imagery tools such as Google Earth which also holds previous satellite imagery
Habitat classification	• MAGIC Maps tool • UK Centre for Ecology and Hydrology land cover maps[2] – (paid for tool) • UKHab and app
Landscape connectivity	• Previous site surveys or plans such as LEMPs • Habitat categorisation by MAGIC Maps tool • Use satellite imagery tools such as Google Earth which also holds previous satellite imagery
Soil surveys	• Planning documentation relating to soil strata/composition • British Geological Survey maps portal[3] • UK Centre for Ecology and Hydrology habitat mapping tools[2] • Soilscapes[4] – free online soil mapping tool for the UK
Presence of species	• Previous site surveys or plans such as LEMPs and ecology surveys

1. https://magic.defra.gov.uk/magicmap.aspx.
2. https://www.ceh.ac.uk/data/information-products.
3. https://www.bgs.ac.uk/geological-data/opengeoscience/.
4. Soilscapes soil types viewer – Cranfield Environment Centre. Cranfield University (landis.org.uk).

Fordie Estate, Scotland, part of Foresight Sustainable Forestry Company Plc's portfolio

Asset manager-led surveys continued

On-site survey

Visual checklist for AMs

Method	Identification method
On-site walk out	Identify main habitat features on site, most likely for solar being: • Grassland • Hedgerows • Grazed land • Trees • Ponds • Drainage ditches From a site walk out, estimate size of habitat area and collate on a map.

Solar arrays at Shotwick Solar Farm

Shotwick Solar Farm

3. Operational Considerations

In this section:

Operational considerations

When considering a solar site, it's important to remember that its primary purpose is to generate electricity as efficiently and in as uninterrupted a fashion as possible. With this in mind, below are some of the key things to take into account when considering the adaptation of management plans or the imposition of new biodiversity focused initiatives at solar sites:

For operational assets:

- Ensuring no part of the modules are shaded from by vegetation
- Unrestricted access to all equipment on site
- Ability to carry out digging works for installation of new components/repair faulty components (e.g. cabling)
- No restrictions to/impact on current security systems
- Compliance with planning regulation and lease agreements/land agreements regulations
- Landowners and grazing rights

Pre-construction:

- No ploughing etc. will be carried out
- Some sites will have access tracks installed and the construction of concrete structures for inverter/transformer stations
- An area of the site will be allocated as the site office/loading area for all components arriving on site
- Due to tight deadlines work is often completed during winter months

During construction:

- There will be a high number of heavy vehicles moving around the site, meaning that ground conditions can get muddy
- Trenches will need to be dug for all the cables to be installed into
- Mounting structures will typically be pile driven into the ground. The depth varies to ground/soil condition and load capacity of the structures
- Concrete foundations will be installed for substations or inverter stations to be constructed on
- If there are concerns about drainage, new drainage will also be installed to maintain easy access to the site
- Sheep protection on all visible cabling should be implemented before grazing begins

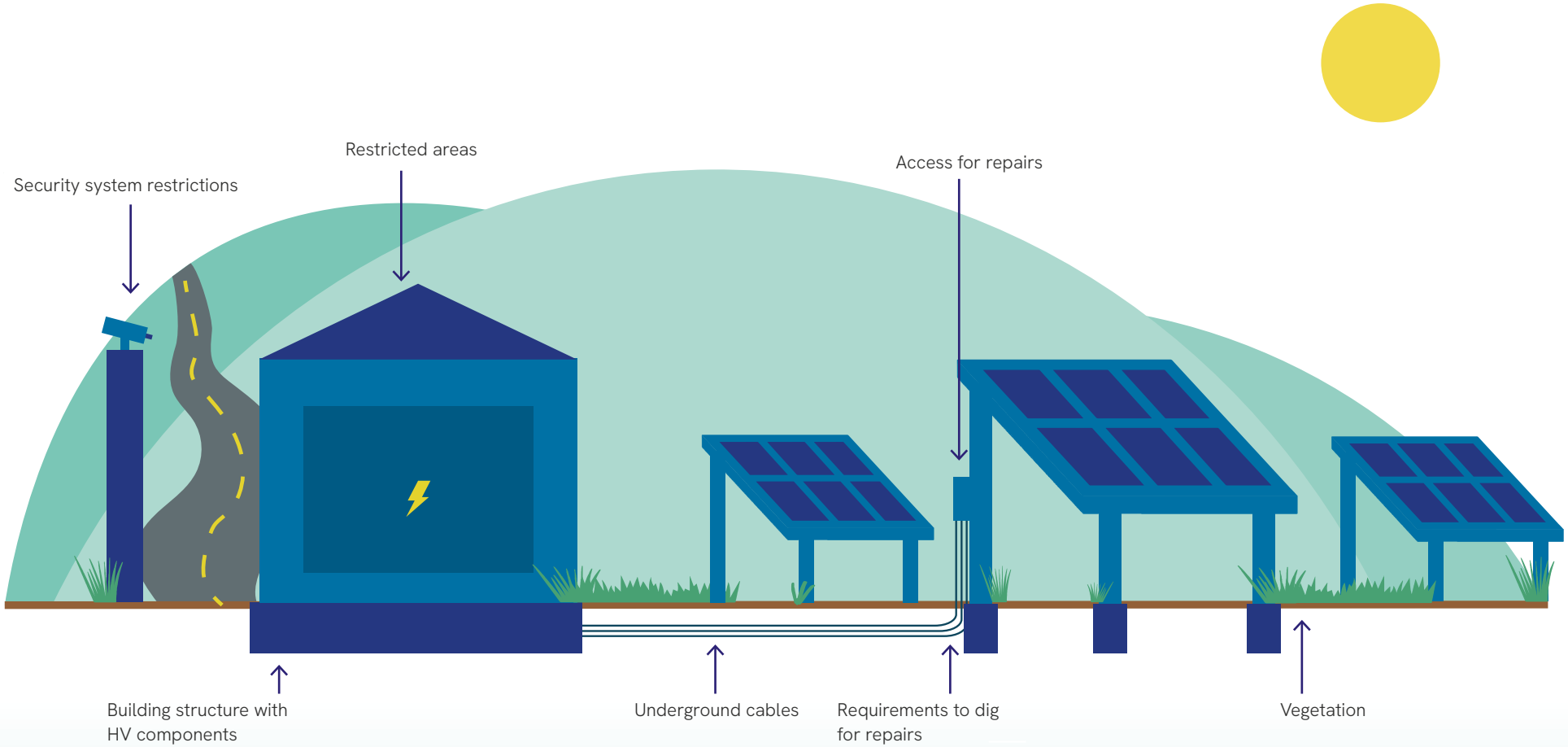
Post-construction:

- Most leases will request that a type of grass is sown across the site or at least that the ground conditions are returned to a similar condition
- This will mean that all ruts etc. will be flattened and, in some cases, large stones removed
- New planting within the fence boundaries needs at least two years to grow strong (depending on the species)
- Grazing should not commence until then

Planting at Foresight Solar Site

Operational considerations continued

Main components of a solar site



Planting at Foresight Solar Site

4. Habitat management

In this section:

Habitat management

How a site is managed will be the single biggest factor in how we can contribute to nature recovery at a landscape scale. Sometimes small changes in management can have big impacts either negatively or positively for biodiversity and ecological processes. Having a mindset that continually balances the operational needs alongside the ecological needs of a site is vital in harnessing the full potential of land for nature under solar use and contributing to overall resilience.

Solar sites often comprise a mosaic of habitats, which can be hugely beneficial in supporting biodiversity. Here are some examples of different types of habitats that are associated with solar sites and related management options.

Shotwick Solar Farm

Grassland and wildflower habitat

Species-rich grassland has a high diversity of native wildflowers and grasses, but it only covers 1% of the UK land area[1]. They play a fundamental role in supporting much of our wildlife, including pollinators, which provide a vital ecosystem service and are essential to our food security. They also reduce the impact of surface water run-off, which can help improve water quality and alleviate flooding at a catchment scale.

Some of the UK's most diverse wildflower habitat was represented in traditional hay meadows, which were managed for making hay to feed livestock over winter. Typically, this involved cutting the meadow in July with aftermath grazing or as pasture with low-level grazing throughout much of the year. As a result, hay meadows were rich in wildlife and provided an essential resource to pollinators.

Since the 1970s the UK has suffered exponential losses in wildflowers for various reasons, such as conversion of hay meadows and wildflower pastures to arable land, use of fertilisers and herbicides and development. As a result of habitat loss, pollinator numbers are in decline. Between 1980 and 2019, 42% of indicator pollinators have become less widespread, with 20% in strong decline[2].

After a solar farm has been installed, few fast-growing grasses are often sown without wildflowers for fast coverage of bare ground. Although this helps prevent soil erosion on new sites, grass and rank vegetation quickly dominates and prevents other flowering plants from establishing. However, with some minor cost-effective interventions and tweaks to the management regime, flowering plant diversity can be sustained, and grass-dominant areas can become more species-rich over time. Research conducted by Lancaster University (Blaydes et al, 2022) showed that land on a solar farm managed for wildflowers rather than grass can boost bumblebee numbers by up to four times[3]. The benefits of which extended up to 1km beyond the solar farm.

There is also huge value to invertebrates in creating structural variation of the plant height (sward) within species-rich grassland, as this mosaic of habitats supports invertebrates through the different stages of their lifecycle. This will in turn encourage wildlife and help improve overall biodiversity on site.

1. Magnificent Meadows statistic: http://www.magnificentmeadows.org.uk/conserve-restore/importance-of-meadows.
2. Status of pollinating invertebrates UK https://www.gov.uk/government/statistics/england-biodiversity-indicators/10-status-of-pollinating-insects--2.
3. Blaydes H., Gardner, E., Whyatt J.D., Potts S.G., & Armstrong A. 2022, Solar park management and design to boost bumble bee populations. Environmental Research Letters.

Planting at Foresight Solar Site

Grassland - Occupied by solar arrays

Types of grassland

Grassland is an area of vegetation that is dominated by grasses and is categorised as lowland or upland (above 300m), depending on geographical location. Species-rich grassland is rare, with over 15 different wildflower species per m^2, they support many threatened species of plants, invertebrates and birds. Restoring species-rich grassland will provide more valuable habitats and connect sites to other species-rich grassland or habitats, which allows wildlife to move across the landscape. It also reduces the need for artificial fertiliser and pesticide.

Grassland can be modified (improved), semi-improved or unmodified (unimproved). Modified grassland has typically undergone high modification or intensive agriculture. They are dominated by fast-growing species, such as ryegrass and white clover with a very limited variety of grasses and flowering plants. Although not species-rich, there is scope to manage for increased biodiversity.

Semi-improved grassland is in transition and sits between modified and unmodified grassland. It has typically undergone some modification through the addition of fertiliser, herbicide or grazing. Semi-improved grassland is a valuable habitat with naturally occurring flora that can be species-rich. Indicator species are a mixture of fine leaved and coarse grasses and plants, such as dandelion, plantain, yarrow and meadow buttercup. Without some form of management in these areas, wildflowers become swamped by grasses and are unable to compete.

Cutting regime and rotations

Action	Impact	Approx. cost (/MW,/ha, etc.)
If grazing is not an option, a flexible cutting regime is the best alternative. Leave grassland areas uncut between April and July–September depending on the weather. Enhance with yellow rattle in the first year by creating patches of bare ground to sow into. Leave grass uncut between October and February, unless growth is vigorous. Cut and collect cuttings in February and March. Leave unmown strips along the margins of fields.	Cutting and collecting grass areas on site in an annual regime will help to reduce the fertility of the soil by preventing the grass from decomposing and returning nutrients to it. In turn, this will help wildflowers to establish through the spring/summer, flower and go to seed. Another impact of removing grass is to avoid the negative impacts of thatch. Thatch is a loose, organic layer of dead and living grass that develops between the zone of green vegetation and the soil surface. This layer can cause problems by producing organic debris faster than it can be broken down and acting like a layer of fertiliser. This accelerates grass growth and allows grasses to become dominant over other species. Yellow rattle will help suppress grass growth and allow other wildflowers to establish. Alternating mowing and leaving un-mown margins or selective plots periodically, will provide a food resource for invertebrates, especially butterflies and bumblebees, birds and other wildlife. Varying sward height helps provide a mosaic of habitats to support species at different stages of their lifecycle.	**MEDIUM COST – Mowing £14.64[1] p/acre** **Baling from £3.04 p/bale depending on bale size**

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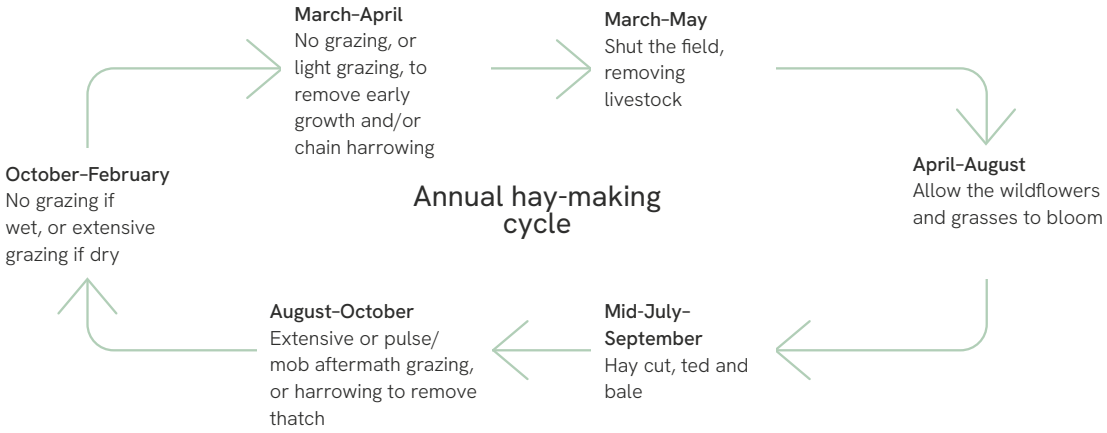
1. Machinery contracting price guide 2023 Microsoft Word - NAAC_Contracting_Prices_Survey_2023_Final-1.docx (windows.net).

Grassland - Occupied by solar arrays continued

Types of grassland continued

Unmodified grassland is naturally occurring species-rich grassland that has not been modified or influenced by human activity. Typically occurring in woodland clearings, high altitudes above tree limits and coastal areas. Soil type can also be used to classify unmodified grassland, such as calcareous (lime rich), acid (sandy, gravel and siliceous) or neutral (clay and loamy). Unmodified grassland contains native fine leaved grasses and wildflowers, such as knapweed, birds-foot trefoil, sorrel, scabious and even orchids.

Annual hay-making cycle[2]



Grazing regime (hay meadows)

Action	Impact	Approx. cost (/MW,/ha, etc.)
No grazing, or light grazing, March to April. Farmers can be instructed to cease grazing and remove livestock from grassland/meadows around solar arrays and field margins between March and May. Allow the wildflowers and grasses to bloom between April and August. Hay cut, ted and bale the grassland/meadows between July and September. Changing between earlier cuts (usually after 15 July) to later cuts (in late August) is beneficial for a hay meadow, rather than cutting at the same time each year. From August to October farmers can be instructed to extensively or pulse/mob aftermath graze (pulse or mob grazing may be used with 1.5-2.25 LU/ha – a short intensive burst of grazing before removing the livestock[1]) or harrow to remove thatch. Do not graze during October and February if wet, or extensive graze if dry[1].	Cutting and removing the hay will help reduce soil fertility of existing grassland on site. This will encourage diversity of wildflowers to grow and create herb and species-rich hay meadows that can also provide revenue to a landowner/farmer when sold as good-quality livestock fodder. Aftermath grazing breaks up any matted vegetation and mosses and pushes seeds onto the soil helping them to germinate. It also helps reduce the grass growth before the wetter autumn and winter weather, allowing light to get to the ground and aiding seed germination.	**NO COST – possible revenue to be made from grazing and good-quality hay, depending on grazing rights etc.**

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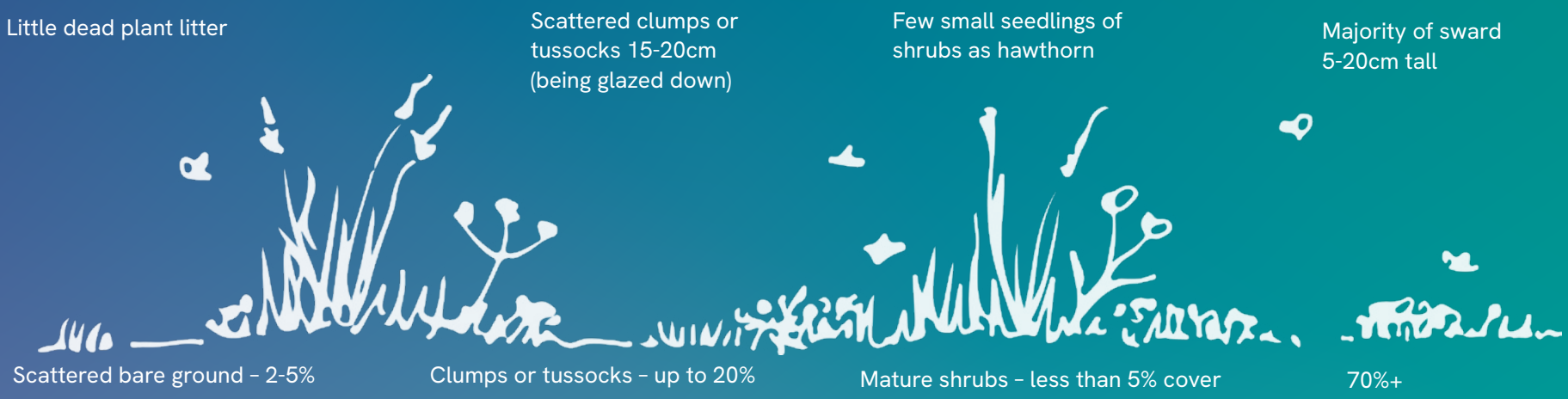
1. Magnificent Meadows advice sheet on grazing: http://www.magnificentmeadows.org.uk/assets/pdfs/Hay_meadow_and_pasture_management.pdf.

Grassland - Occupied by solar arrays continued

Sward height diagram[1]



Structural variation of sward height

Action	Impact	Approx. cost (/MW,/ha, etc.)
Create structural variation of plant height (sward) by cutting areas of grassland to different lengths. Ideally achieving a succession of different types from bare ground to short open turf, tall grass and tussocks. This can be achieved with a lawnmower and strimmer. Some areas of tall grass can be left on a two to three-year cutting rotation.	Creates diversity in the grassland to support invertebrates at different stages in their lifecycle, which in turn attracts small mammals, reptiles, amphibians and birds. Tussocks are especially important in creating a microhabitat with a different microclimate. This provides nesting and overwintering sites for some bumblebees, ground beetles and others, and food plants for caterpillars of moths and butterflies.	**LOW COST – From £40 p/hr**[2]

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1. Sward height diagram reference: https://www.sruc.ac.uk/media/l1omdteo/tn629-rich-grasslands.pdf.
2. Machinery contracting price guide 2023 Microsoft Word - NAAC_Contracting_Prices_Survey_2023_Final-1.docx (windows.net).

Grassland - Unoccupied by solar arrays

Reduced cutting regime on rotation (two to three years)

Action	Impact	Approx. cost (/MW,/ha, etc.)
If nature recovery focused and proactive grass management regimes are not feasible for cost purposes, a 'no cut' regime can be implemented as a means of increasing biodiversity. Areas of grass can be identified for permanent pasture and left to grow on a two to three-year cutting rotation. However, grass should not obstruct solar arrays and access to equipment should still be achievable for maintenance.	Allowing grassland to go through succession and create more diverse and varied habitats as part of a mosaic on site could increase overall biodiversity.	**NO COST**

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Cut and collect

Action	Impact	Approx. cost (/MW,/ha, etc.)
Cut grass at least once, preferably twice a year; times of year are specified below. Ensure cuttings are removed by either baling or depositing in a central location. They can be sold or donated and therefore taken off site without incurring extra cost. Cuttings can also be used to top off a hibernacula made for overwintering species.	The removal of grass cuttings reduces soil fertility, allowing for more robust species of wildflower and grass to thrive. Cutting at the right time of year allows these species to complete their seasonal cycle, ensuring maximum seed dispersal for the following year.	**MEDIUM COST – Mowing £14.64[1] p/acre** **Baling from £3.04 p/bale depending on bale size**

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1. Machinery contracting price guide 2023 Microsoft Word – NAAC_Contracting_Prices_Survey_2023_Final-1.docx (windows.net).

Hedgerows

Hedgerows are characteristic of farmland in Britain that have been with us since the Bronze Age. Originally established to demarcate field boundaries, land ownership and restrict livestock movement. British hedgerows can vary from almost single species planted hedges of hawthorn (*Crataegus monogyna*) or beech (*Fagus sylvatica*) through to rich mixtures of shrubs, trees and ground plants of ancient hedgerows. Plant species typically found in hedgerows can include blackthorn (*Prunus spinosa*), hazel (*Corylus avellana*) and ramblers like bramble (*Rubus fruticosus*) and dogrose (*Rosa canina*), with occasional larger trees such as ash (*Fraxinus excelsior*) and field maple (*Acer campestre*).

In 1997 the Hedgerows Regulations Act[1] was passed, which applies to England and Wales. The act requires any person to obtain permission before removing a hedge or hedgerow. Even small hedgerows may need permission for their removal, if, for example, they are over 30 years old, or form part of an old field system. Small hedges or hedgerows may also be important if they are species rich; for example, having seven woody species or have particular herbaceous woodland species in them or nearby (e.g. bugle, wood anemone, dog violet).

Over the last 20 years, there has been increasing awareness within the farming community and landowners of the huge benefits of hedgerows to wildlife and their role in supporting biodiversity locally, as well as providing corridors to the wider landscape. Hedgerows may support up to 80% of our woodland birds, 50% of our mammals and 30% of our butterflies. The ditches and banks associated with hedgerows provide habitat for frogs, toads, newts and reptiles[2].

They provide essential highways for threatened species, such as dormice and hedgehogs, connecting them to fragmented areas of woodland and the wider landscape.

Hedgerows have declined rapidly in recent years, approx. 189,902km of hedgerow have been lost since 1950, mainly because of the intensification of agriculture. Although the rate of loss has slowed neglect, damage and removal of hedgerows still threaten this vital habitat[3]. A hedgerow survey undertaken by The UKCEH, Countryside Survey, in 2007 estimated that there were 477,000km of 'managed' hedgerows and 114,000km of 'relic hedges' left in the UK[4]. This is half the amount of hedgerows estimated by the Forestry Commission in the 1950s[5]. A managed hedgerow is a line of woody vegetation that has been subject to management so that trees no longer take their natural shape. Whereas, relic hedges do not form part of field or stock boundaries, but which have become rows of trees (or linear coppice).

Many bird species depend on hedgerows for their survival throughout the year, especially in areas where there are few woods or woodland is heavily fragmented. In winter, hedgerows can be used for feeding and roosting sites for resident birds and winter visitors, such as fieldfares (T*urdus pilaris*) and redwings (*Turdus iliacus*).

There are 30 species of birds that nest in hedgerows, but when it comes to nesting, some species are fussier than others! This highlights the importance of managing for a range of hedge heights and tree densities and to maintain a grassy verge at the base of the hedge. Hedgerows should not be cut or trimmed during breeding bird season from March to August annually. Below is a table showing examples of bird species and their different nesting preferences:

Hedgerow nesting preference type	Example bird species
Tall hedgerows >4m with lots of trees	Bullfinch and turtle dove
Shorter hedgerows 2-3m with fewer trees	Whitethroat, linnet and yellowhammer
Medium or tall hedgerows with fewer trees	Dunnock, lesser whitethroat and willow warbler
Well above ground level in any hedgerow with a tall tree nearby to sing from	Song thrush, blackbird, chaffinch and greenfinch
Low down in any hedgerow	Wren, robin, dunnock and whitethroat
Ground level in hedgerow that has a grassy verge at the base	Grey partridge

1. The Hedgerows Regulations Act (1997) https://www.legislation.gov.uk/uksi/1997/1160/contents/made.
2. RSPB hedgerow statistics https://www.rspb.org.uk/helping-nature/what-we-do/influence-government-and-business/farming/farm-hedges.
3. https://www.woodlandtrust.org.uk/trees-woods-and- wildlife/habitats/hedgerows/#:~:text=Around%20118%2C000%20miles%20of%20hedgerows,be%20more%20damaging%20than%20others.
4. The Countryside Survey 2007 https://countrysidesurvey.org.uk/.
5. The Forestry Commission https://www.forestryengland.uk/we-are-evolving.

Hedgerows continued

It is not just birds that are particular about their hedgerows; hazel dormice (*Muscardinus avellanarius*) only appear to nest in hedges that are left to grow larger and with a more diverse range of plant species. They rely on hedgerows for food, shelter, nesting, hibernation and corridors to disperse. Dormice can travel up to 300m per night in hedges to forage for food.

Due to hedgerow loss and poor management, dormice have declined by 64% in hedgerows since the 1970s[1]. An absence of dormice in hedgerows means they have become isolated in unconnected woodlands, thus depleting the resources and mating opportunities available to them. Dormice are one of those bioindicator species that raise a red flag for biodiversity loss; if they are not present, other species are likely to have been lost too.

It is estimated that the hedgehog (*Erinaceus europaeus*) population has fallen by 33-77% within the last 20 years in the UK[2], primarily due to loss of nesting and foraging habitat through urban development and hedgerow removal (rural). Hedgehogs prefer a thick-based hedge with tussocky vegetation and plenty of twiggy material and leaves[3]. This creates suitable cover for daytime habitat and winter hibernation sites. Hedgehogs can often be found nesting under the dense low cover of bramble outgrowths. Maintaining shallow, sloping, moist hedge ditches and wide field margins will provide foraging opportunities for hedgehogs during the spring and summer months.

To maximise the potential of hedgerow habitat as a wildlife corridor, management should be considered on a landscape scale. Undertaking a desktop survey of priority habitat in protected species within a 2km radius of the site will better inform a hedgerow management plan. To preserve hedgerow habitat long term and to ensure there is always some blossom and fruit available, they must be managed on a cycle of periodic rejuvenation, to reset the hedge cycle as the hedge shrubs mature.

Hedgehog and dormouse are protected in the UK under the Wildlife and Countryside Act, 1981. They are Priority Species under the UK Post-2010 Biodiversity Framework and listed on the IUCN Red List for British Mammals as vulnerable to extinction. Small changes to hedgerow management can provide habitat for these vulnerable species and protect them against extinction.

Cutting rotations

Action	Impact	Approx. cost (/MW,/ha, etc.)
A staggered management approach means that the site will have hedgerows of differing heights, at any one time. Cut hedgerows in two to three-year intervals on rotation. Aim to stagger the hedges on your site across the hedge management cycle so that there are always hedges of varying heights: some cut, some uncut, some in non-intervention periods and some ready for rejuvenation. Allow for thick hedges with wide bases that provide plenty of cover with a variety of heights, shapes and sizes.	Increased nesting, foraging, hibernation, mating and commuting opportunities for a wide range of bird species, hedgehog and hazel dormouse (if a population has been identified nearby). Increases the production of buds, fruit, nuts and seeds available for dormice, birds and other wildlife. Provides a wide range of hedgerow habitats that suits varying hedge preferences of different species.	**LOW COST – from £47.50 to £60 p/hr**[4]

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1. Dormouse facts https://ptes.org/campaigns/dormice/hazel-dormouse-conservation/hedgerow-management-for-hazel-dormice/.
2. Hedgehog facts https://www.nhm.ac.uk/discover/news/2022/february/britains-rural-hedgehogs-see-dramatic-population-decline.
3. Hedgehog hedgerows https://hedgelink.org.uk/cms/cms_content/files/40_hedgehog_%26_hedges_leaflet.pdf.
4. Machinery contracting price guide 2023 Microsoft Word - NAAC_Contracting_Prices_Survey_2023_Final-1.docx (windows.net).

Hedgerows continued

Enhancement of existing hedgerows

Action	Impact	Approx. cost (/MW,/ha, etc.)
Enhancement or enlargement of existing hedgerows through changes to management, restoration and gapping-up of neglected hedgerows, and extending hedgerows to connect areas of fragmented woodland or lines of trees, where possible. Leave a grass verge at the base of an existing hedge. Maintain a shallow, sloping hedge ditch.	Trees, particularly oaks, support a rich variety of invertebrates and are good birdsong posts. Old trees have holes where blue tits, owls and kestrels, as well as bats, can nest. Leaving grassy hedge bottoms will provide nesting material and insect larvae for chicks to feed on. Wildflowers and grasses growing up into a hedge also help to conceal nests from predators.	**LOW COST – £47.50 to £60 p/hr**[1]

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Table of suitable wildflowers for hedges[2][2]

Any location	Climbers	Shade tolerant/woodland	Chalk only
Agrimony	Birdsfoot trefoil	Foxglove	Dark mullein
Common St John's Wort	Dog rose	Greater celandine	Greater knapweed
Field scabious	Hedge bedstraw	Greater stitchwort	Small scabious
Lady's bedstraw	Honeysuckle	Primrose	Wild majoram
Lesser knapweed	Meadow vetchling	Red campion	
Meadow cranesbill	Tufted vetch	Sweet violet	
Oxeye daisy		Wood avens	

1. Machinery contracting price guide 2023 Microsoft Word - NAAC_Contracting_Prices_Survey_2023_Final-1.docx (windows.net).
2. Flowers, C., 2008, Where Have All the Flowers Gone, Papadakis, Berkshire. UK.

Hedgerows continued

Do nothing during breeding bird season

Action	Impact	Approx. cost (/MW,/ha, etc.)
Do not cut, trim or remove hedgerows during breeding bird season. This will cause distress to nesting birds, and they will abandon their offspring and the nest. They will have expended a lot of energy on their first brood, which may impact on their potential to mate again and successfully raise another brood that year.	Nesting birds remain undisturbed during the breeding season, which gives them the best opportunity to mate and raise a brood that year.	**LOW COST – £50 to £60 p/hr**[1]

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Healthy hedgerow survey and management plan

Action	Impact	Approx. cost (/MW,/ha, etc.)
Download Healthy Hedgerows[2], a free rapid assessment hedgerow survey app to conduct a rapid hedge health survey of the hedgerows on your site. By answering a handful of simple questions, this hedgerow health checker will place each hedge you survey in the hedgerow lifecycle and give you instant management options.	Better understanding of the whole hedge network on a site and enables you to create a hedge management plan[3] at the farm scale. Staggering hedgerow management is not only better for biodiversity, but also more cost effective.	**NO COST**

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1. Machinery contracting price guide 2023 Microsoft Word - NAAC_Contracting_Prices_Survey_2023_Final-1.docx (windows.net).
2. PTES Healthy Hedgerow app https://hedgerowsurvey.ptes.org/healthy-hedgerows-survey.
3. PTES Healthy Hedgerow Management Plan https://hedgerowsurvey.ptes.org/creating-a-hedge-management-plan.

Hedgerows continued

Rotational cutting regime

Action	Impact	Approx. cost (/MW,/ha, etc.)
Leaving hedgerows to thicken and grow tall is advantageous to birdlife, but not cutting at all can be as bad as cutting annually to the same height. All hedgerows need to be managed on a cycle if they are to survive in the long term. Therefore, it is advised to manage all hedgerows on site on a staggered management approach and cut on a two to three-year rotation, as specified above.	If hedgerows are left uncut close to solar arrays this could pose a fire risk, obstruct access or malfunction. Hedgerows can become scrubby and encroach on adjacent habitats that are being managed to increase diversity on the site, such as species-rich grassland habitat.	**NO COST**

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Example of Hedgerow

Boundary features

Boundary features, in addition to hedgerows, also play an important role in providing refuge and a corridor for wildlife. Features such as rough grass verges, field margins, tree lines, stone walls and scrub can be used to connect fragmented patches of habitat, enabling wildlife to safely disperse into the wider landscape to find resources and mating opportunities.

Bare earth and banks provide habitat for solitary bees, such as mining bees. Different bees hibernate and emerge at different times of the year, coinciding with the flowering of their favourite nectar sources.

The crevices in stone walls provide habitat to invertebrates, amphibians, reptiles and small mammals at various stages in their lifecycle, such as overwintering sites for masonry bees and newts. They play host to mosses, lichens and liverworts, which create moist and humid microclimates suitable for microscopic invertebrates. Both mosses and lichens play an important role in a healthy habitat because they absorb carbon dioxide and other pollutants from the air.

Scrub is classified as patches of shrubs less than 5m tall with continuous (>90%) cover. Relevant shrub species include blackthorn (*Prunus spinosa*), hazel (*Coryllus avellana*), sea buckthorn (*Hippophae rhamnoides*) and bramble (*Rubus fruticosus agg.*). Scrub is a valuable habitat. It provides shelter, overwintering, food and nesting sites for birds and other wildlife, such as hedgehogs. It is also important for invertebrates, providing flowers for bees and other pollinators.

Trees are being lost from the landscape faster than they are being replaced. Pests and diseases such as ash dieback have increased the rate of loss. Unless existing trees are retained and managed well, the landscape could profoundly change. Boundary trees are important structures in the landscape. They provide many environmental benefits for the small area they take up. Mature boundary trees generally have full, open-grown crowns, unshaded by other trees. This makes them particularly important for lichens and the species that feed on them. They also create a wide range of habitats, different to those of woodland trees. Old trees containing dead and decaying wood are the most important for wildlife[1].

It is common to find problematic plant species, referred to as invasive non-native species or INNS, on site boundaries as they are often the first to colonise open areas and edges of habitat. Some species, such as giant hogweed (*Heracleum mantegazzianum*), Japanese knotweed (*Fallopia japonica*) and Himalayan balsam (*Impatiens glandulifera*) can spread prolifically, creating a monoculture of a single plant species that outcompete slower growing plant species native to the UK. This is a problem because it reduces vegetation heterogeneity (structure and composition) and subsequently, biodiversity. Where there are instances of large-scaled infestations of INNS on a site, eradication of some species may not be possible. Instead, a long-term management plan is required to keep INNS under control on a site and prevent it from spreading into neighbouring land.

If you find invasive non-native plants on site, you must stop them from spreading and causing a nuisance or damage to other land or property. If you do not, you could be responsible for any damage they cause and may be prosecuted[2].

1. https://defrafarming.blog.gov.uk/sustainable-farming-incentive-pilot-guidance-maintain-trees-along-field-boundaries/.
2. Legislation on INNS plant species https://www.gov.uk/guidance/prevent-the-spread-of-harmful-invasive-and-non-native-plants.

Example of Boundary

Tree line

Tree lines are stands of trees often forming part of the boundary or habitat edge. If they stand alone, they sometimes mark the site where a hedgerow existed previously. **Please note that tree work must be avoided during nesting bird season, which runs throughout March to August annually.**

Maintenance

Action	Impact	Approx. cost (/MW,/ha, etc.)
Contract a reputable arboricultural contractor to inspect and maintain trees lines on the periphery of the site and in hedgerows for health and safety purposes and disease. Overhanging limbs to be pruned and removed before they become a risk to safety or assets. Diseased trees to be removed where identified. The best time to undertake tree work is in the autumn/winter after the leaves fall and before buds burst. This depends heavily on temperature and can vary depending on annual fluctuations in temperature.	Diseases are picked up before they become a problem. Trees are made safe, and features of ecological value are maintained.	**MEDIUM COST – from £210 per tree**

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Standing dead wood

Action	Impact	Approx. cost (/MW,/ha, etc.)
Leaving standing dead wood (that is not diseased) within existing woodland habitat where it does not pose a risk to H&S or assets. This is done by identifying trees that are dead and do not require removal for any specific reason. Some trimming of limbs and branches may be required to make the tree safe. This will need to be done by a professional arboriculturalist.	Leaving standing dead wood provides highly valuable habitats for wildlife, such as roosting and foraging opportunities for birds and bats. Single, tall dead trees provide excellent perches for birds of prey whilst hunting.	**MEDIUM COST – from £210 per tree**

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Tree line continue

Hibernacula

Action	Impact	Approx. cost (/MW,/ha, etc.)
Collect and stack dead, fallen or cut tree limbs to create hibernaculum to provide overwintering sites for small mammals, amphibians, reptiles and invertebrates. Trees that have been felled can be cut and stacked on the edge of woodlands or at the base of hedgerows. Top with leaves and grass cuttings.	Dead wood provides habitat to a multitude of invertebrates that depend on dead, decaying or living wood, or associated fungi, at some stage in their lifecycle.	**NO COST or LOW COST depending on site material and labour**

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Connecting/extending existing boundary line

Action	Impact	Approx. cost (/MW,/ha, etc.)
Assess boundary trees for connectivity to the wider landscape. Extend the tree line where possible to connect with fragmented areas of woodland, scrub and hedgerows. In-fill large gaps in hedgerows or where trees have died with new tree whips. Remove tree guards where they have been outgrown. Use an arboricultural contractor to prune back overhanging branches that pose a threat to health and safety and/or assets. If full-grown boundary trees are not an option, consider establishing heavily pruned (pollard) willows around fields. These provide important habitat for ground-nesting birds.	Boundary trees support species-rich hedges, fragmented patches of woodland, ditches or banks. They provide opportunity for birds to roost away from predators, and corridors and roosting opportunity for commuting bats.	**LOW COST – from 20p to 60p per tree or £500 p/acre depending on species, plus £15.50 p/hr labour**

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Scrub

Scrub habitats are important for invertebrates, birds and mammals providing nectar, shelter, nest sites and hunting areas. Scrub that has a variety of species ages and structures can support a wide range of biodiversity by providing a range of habitat for different species lifecycles and growth habits. To get the best results for nature, it is important to maintain a range of scrub stages from bare ground to young and old growth.

Birds are particularly reliant on scrub for nesting, including; yellowhammers, linnets and grasshopper warblers, which prefer scattered scrub; dunnocks and willow warblers that prefer low-growing closed canopy scrub; turtle doves and song thrushes need older, mature stands of scrub; nightingales require dense stands of blackthorn or bramble.

However, left unmanaged scrub will turn into woodland, so maintenance is key to providing its characteristic ecology and habitat value[1].

Example of Scrub

1. https://www.rspb.org.uk/helping-nature/what-we-do/influence-government-and-business/farming/conservation-land-management.

Scrub continued

Cutting rotations

Action	Impact	Approx. cost (/MW,/ha, etc.)
Scrub can be cut and deliberately allowed to grow up to provide habitat for wildlife and pollinators. Manage for a mix of young and mature scrub on site. Link up areas of scrub with stands of trees, woodland and hedgerow, where feasible. Manage scrub to maintain a mosaic of habitat features on the site. Avoid cutting scrub during nesting bird season. Zonation or graduation of scrub allows habitat variation. However, prevent scrub from dominating and encroaching on habitat of high ecological value, such as species-rich grassland or woodland understorey. Add arisings from scrub cutting to the top of stacked wood to top off hibernaculum.	Maintaining areas of scrub on a site is hugely beneficial to wildlife. Scrub provides cover for breeding birds and overwintering mammals, foraging opportunities for birds and pollinators, and connectivity to fragmented woodland, hedges and the wider landscape. Having young and mature scrub ensures some blossom and berries at any one time on a site.	**LOW COST – from £60 – £70 p/day**

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Managing Non-native invasive species (NNIS)

Action	Impact	Approx. cost (/MW,/ha, etc.)
Non-native invasive species (NNIS), such as Himalayan balsam and Japanese knotweed, can become problematic on a site if left unmanaged. Undertake a short and free online biosecurity course with the Non-native Species Secretariat[1] to help you identify problematic species and prevent the spread of NNIS. It is advisable to undertake a walkover survey for INNS every six months. Some species, such as Japanese knotweed, require a long-term (five years+) herbicide treatment plan to control the spread. A specialist contractor may be required to survey the site to produce and implement a management plan. Other plant species, such as Himalayan balsam, require manual removal from the root to eradicate, which could take years.	Due to their ability to grow and spread fast, non-native invasive species outcompete more slow-growing native species by blocking out the light and reducing nutrient availability. This reduces vegetation heterogeneity and consequently, biodiversity.	**LOW COST – from £200 depending on the size of the site**

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1. Non-native Species Secretariat (NNSS) Biosecurity Training: https://www.nonnativespecies.org/biosecurity/.

Stone walls

Stone walls acts as a host for biodiversity as well as acting as corridors to allow species to move, and as staging posts for birds. Shade cast by stone walls can also provide niche habitat conditions for some species.

Maintenance

Action	Impact	Approx. cost (/MW,/ha, etc.)
Some stone walls are very old and could be a heritage feature and protected by law. Repair and maintain existing stone walls that may show signs of degradation. Rebuild collapsed areas using traditional stone wall methods. Traditional stone walling requires a skilled and experienced stone mason.	Stone walls are host to a plethora of wildlife. The gaps and crevices provide overwintering sites for amphibians, small mammals and reptiles. They provide microclimates for a whole host of different plant and invertebrate communities, at varying lifecycles. Protected species, such as great crested newts, have been found to overwinter in stone walls within a 500m radius of a pond.	**MEDIUM COST – £200 p/tonne for stone, plus £200 p/m² for labour**

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Verges/field margins

Verges and field margins provide semi-natural habitat for animals, birds and invertebrates and have been considered as a target area for enhancing biodiversity as they often seen as occupying land with less economic value. These areas can support a wide diversity of plants and act as buffers for protecting hedgerows, ditches and streams from land operations. They can form a network across the landscape linking bigger areas of habitat[1].

Cutting regime

Action	Impact	Approx. cost (/MW,/ha, etc.)
Field margins are easy-to-manage strips of naturally growing vegetation that are found along the edge of fields beside linear features such as hedgerows. Verges are strips of vegetation typically found along pathways, roads and tracks. Margins and verges should be cut in autumn after plants have flowered, at least once every three years, and this will prevent the vegetation within the margin becoming too rank or turning into scrub. They can also be cut on rotation, leaving some uncut on a two to three-year cycle and some cut annually. The margin between security fencing and hedgerow can be managed at low intensity to form tussocky habitat.	Verges and field margins provide habitat and corridors for small mammals, reptiles and birds. They are comprised of a variety of plants including wildflowers and grasses that produce flowers and seeds which benefit seed-eating birds such as the house sparrow, the linnet and the yellowhammer. Pollinators like bumblebees and solitary bees benefit from pollen and nectar from the margin's flowering plants. Rotating cuts will create variation in sward height, providing at least some long vegetation for overwintering species. Margins also act as a buffer to surface water run-off, slowing the flow and filtering the water, enabling soil and pollutants to drop out before entering the water course.	**LOW COST – from £47.50 to £60 p/hr**[2]

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1. https://agricology.co.uk/sites/default/files/Field%20margins,%20hedgerows,%20woodland%20and%20scrub.pdf.
2. Machinery contracting price guide 2023 Microsoft Word – NAAC_Contracting_Prices_Survey_2023_Final-1.docx (windows.net).

Woodland

Woodlands are facing a combination of pressures, including climate change, development, intensive agriculture, pollution and pests and diseases. Between 2001 and 2021, the UK lost 105,000 hectares of tree cover, which equates to a 6.9% decrease in tree cover over 20 years[1]. Woodlands are now estimated to cover only 12% of the UK.

Inappropriate development has caused woodland to become heavily fragmented, which means that stands of woods become isolated and disconnected to the wider landscape. This is problematic because if species cannot move freely through the landscape, they too become isolated, depleting local resources and causing a reduction in genetic diversity required for adaptation to changing environmental conditions.

The UK Wild Bird Populations Indicator for woodland bird species show a long-term decline of 27% since the early 1970s, with declines of 7% evident over just the last five years. Some specialist woodland birds have declined dramatically, including willow tit (*Poecile montanus*) with a 94% decline since 1970[2].

Woodlands in the UK are estimated to soak up approx. 21 million tonnes of carbon dioxide a year. That's around a third of the carbon dioxide emitted by cars every year in the UK. Woodland plays a key role in addressing climate change with their carbon storage potential but are less well known for their potential to limit flooding events. Wet woodlands provide a great service in slowing the flow of water downstream after extreme rain events[3].

Due to environmental pressures such as a warmer and wetter climate, native trees are under increasing stress from pests and disease. Ash dieback (*Hymenoscyphus fraxineus*) will kill up to 80% of ash trees across the UK. At a cost of billions, the effects will be staggering. It will change the landscape forever and threaten many species which rely on ash.

More than 1,000 irreplaceable ancient woods have been threatened by development over the last 10 years, compounded by oak trees suffering the impact of acute oak decline[4]. Ancient woods and trees are some of our most valuable natural assets[5]. They are irreplaceable and home to many vulnerable and threatened species.

Coppicing is an ancient woodland management technique that dates to the Stone Age. Once used to ensure regular supplies of timber and firewood, it involves felling trees at their base to create a 'stool' where new shoots will grow. You can recognise a coppiced tree by the many thin trunks or 'poles' at its base. Most tree species can be coppiced but the best suited of our native trees are hazel, sweet chestnut, ash and lime[6]. Today, there is less demand for coppiced timber and coppicing is primarily used as a conservation practice to create a range of habitats for plants and wildlife as it dramatically increases the diversity of species within woodland.

Hazel dormice (*muscardinus avellanarius*) live in broadleaved deciduous woodland with vigorous field and scrub layers. Actively coppiced woods with a variety of tree and shrub species, and particular Hazel (*Corylus avellana*), offer good habitat, especially in the middle stages of growth where the canopy offers continuous arboreal pathways.

It's also important to remember that woodlands are not just about trees. The vegetation dynamics of what happens below the trees is also important but often overlooked. Managed well, these habitats support an important understory including familiar species such as bluebells and primroses. It is possible to re-invigorate species poor woodlands and increase biodiversity by opening up areas to receive more light (glades), coppicing to increase variable light conditions or introducing wildflower seeds from donor sites. Where new woodlands are being created it can take a long time for woodland plants to colonise, so the understory should be considered as early as possible alongside tree planting[7].

Example of Woodland

1. United Kingdom Deforestation Rates & Statistics | GFW (globalforestwatch.org).
2. https://www.gov.uk/government/statistics/wild-bird-populations-in-the-uk/wild-bird-populations-in-the-uk-1970-to-2021.
3. Woodland | The Wildlife Trusts.
4. https://www.woodlandtrust.org.uk/.
5. https://www.woodlandtrust.org.uk/protecting-trees-and-woods/threats-to-woods-and-trees/.
6. Coppicing https://www.nationaltrust.org.uk/discover/nature/trees-plants/what-is-coppicing.
7. Woodland Wildflowers Work, Landlife, 2005.

Woodland continued

Establishing a woodland management plan is highly recommended as successful woodland conservation requires thoughtful planning based on the understanding of the habitat needs of species present on site. An ecology survey is the first step to determine habitats and quality of them on site. Consult your local Woodland Trust or Wildlife Trust for advice prior to undertaking any woodland management work.

Standing dead wood

Action	Impact	Approx. cost (/MW,/ha, etc.)
Leaving standing dead wood (that is not diseased) within existing woodland habitat is highly beneficial to the healthy function of a woodland ecosystem (where it does not pose a risk to Health and Safety or assets). This is done by identifying trees that are dead and do not require removal for any specific reason. Some trimming of limbs and branches may be required to make the tree safe, but other than that, they can remain in situ. This may need to be done by a professional arboriculturalist, if there is no one trained and competent on site.	Wood decomposition is one of a woodland's essential recycling processes and a natural part of every tree's lifecycle. Dead or decaying wood plays host to a multitude of invertebrates and provides nutrient-rich habitat for fungi, which underpins a woodland ecosystem. The main groups are beetles and flies. More than a fifth of the fauna in a woodland depends on dead, decaying wood. Leaving standing dead wood provides highly valuable habitat for wildlife, such as roosting and foraging opportunities for birds and bats.	**NO COST to LOW COST - £65 - £90 p/day**

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Woodland continued

Scrub management in woodland

Action	Impact	Approx. cost (/MW,/ha, etc.)
Scrub is the transitionary stage between open habitats such as grassland and closed canopy woodland. It is valuable habitat for wildlife, but most forms of scrub need management if they are to persist. If left, scrub will turn into woodland. Native scrub species such as hawthorn and bramble will benefit wildlife from rotational cutting to maintain a variety of growth stages. However, non-native species, such as rhododendron, can dominate the woodland understorey and outcompete native plant species. If rhododendron is present, it will become invasive and need to be removed. Take advice from a specialist organisation such as the Woodland Trust, local Wildlife Trust or an ecologist to determine the condition of the woodland understorey. If some scrub clearance is recommended, this should be conducted outside of nesting bird season, which is throughout March to August.	Scrub can be very valuable for a wide range of wildlife and from part of the habitat mosaic on a site. It provides a continued source of nectar, fruits, seeds, shelter, breeding and roosting sites. A stand of scrub with varied plant species, age and structure will support a great variety of species. Management of scrub in the right locations enables woodland wildflower species to establish in glades and woodland understorey.	**NO COST to LOW COST – £65 – £90 p/day**

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Woodland continued

Coppicing

Action	Impact	Approx. cost (/MW,/ha, etc.)
Coppicing is a traditional method of woodland management which encourages species of trees or shrubs to put out new shoots from their stump or roots if cut down. It is a specialist skill that requires a suitably qualified arboriculturalist to undertake the work. If a site has recently been acquired and it looks like the woodland has been coppiced, an arboricultural survey and management plan is highly recommended. Coppice woodlands are often divided into sections called coupes or cants, which are then cut 'on rotation'. The trees in one coupe are harvested for their timber in one year, and those in the next coupe the next year, and so on, until the process comes back to the first coupe. The length of the rotation cycle for a coppice depends on the type of tree and how long it takes to produce poles of a suitable size and length. For example, hazel is usually coppiced on an eight-year cycle, while chestnut has a cycle of 15-20 years. If the woodland has been identified as ancient from an ecology survey, further assessment is required by an arboriculturalist to develop a woodland management plan.	Coppicing is widely regarded as a priority management practice for ancient woodland. Although traditionally used to provide a sustainable supply of wood, it can also serve to maintain populations of rare species, and create a variety of habitat structures supporting a high diversity of species. Having laid dormant and deprived of light, plant species such as bluebells, wood anemones and marsh marigolds will benefit from sunlight reaching the understorey and begin to flower. After a few years, brambles and climbing plants such as honeysuckle take over. Many of these species are food sources for butterflies and other invertebrates, which in turn provide food for birds, bats and other mammals. Dormice depend on the diverse type of woodland created by coppicing, which results in a dense understory – the layer of vegetation below the main canopy.	**MEDIUM COST – from £15,500 per survey and £500 p/day**

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Woodland continued

Ecotones/softening woodland edges

Action	Impact	Approx. cost (/MW,/ha, etc.)
The best woodland edges support a varied habitat structure and will comprise of a series of graduated zones between the wood and the open area. Ideally these zones will comprise: 1) native tree species, then 2) a mix of scrub species, 3) tall herbs and grasses, finally 4) shorter herbs and grasses with some bare ground[1]. Take advice from a specialist organisation such as the Woodland Trust, local Wildlife Trust, or an ecologist, to identify habitats present on site and their condition. Any vegetation clearance recommended should be conducted outside of nesting bird season, which is throughout March to August.	The woodland edge is a junction between two different landscape elements. This transition zone is where species mix with their respective neighbouring communities and the result is a habitat of great value to wildlife. It also acts as a corridor for migration and seed dispersal. Even for butterfly species strongly associated with the tree canopy, such as purple emperor (*Apatura iris*), purple hairstreak (*Neozephyrus quercus*), or with shaded areas, white admiral (*Limenitis camilla*), woodland edges are still important for nectar resources or for finding a mate.	**NO COST to LOW COST – £65 – £90 p/day**

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1. Woodland edge habitat for butterflies: https://butterfly-conservation.org/sites/default/files/woodland-scallop-factsheet.pdf.

Woodland continued

Scalloping woodland edges

Action	Impact	Approx. cost (/MW,/ha, etc.)
Typically, wood edges are very abrupt, and many rides are narrow and shady. Butterfly-friendly edge habitat can be created through a programme of scallop creation within the ride network of most woods[1]. This can be achieved by cutting a "D" shaped scallop on the side of a woodland ride to create more edge habitat than merely cutting the adjacent length of the ride. Cutting scallops on opposite sides will increase the amount of sunlight and warmth reaching the centre of that ride. The warmest and most valuable scallops will be those which are south facing on east-west rides, as they will receive sun for most of the day. A parallel cutting regime (with opposite facing scallops) can be applied for species preferencing a specific aspect and provide various states of regrowth. Or a linear cutting regime (with offset scallops) that creates more varied habitat growth form one end to the other.	Cutting scallops creates a varied, zoned edge structure to the woodland. Scallops also reduce shading along the adjacent ride and have great potential to improve any existing ride side butterfly habitat. They will increase the overall structural diversity of the woodland and provide sheltered herb-rich grassy areas.	**NO COST to LOW COST – £65 – £90 p/day**

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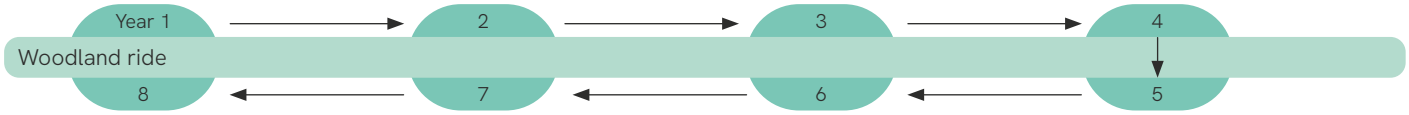
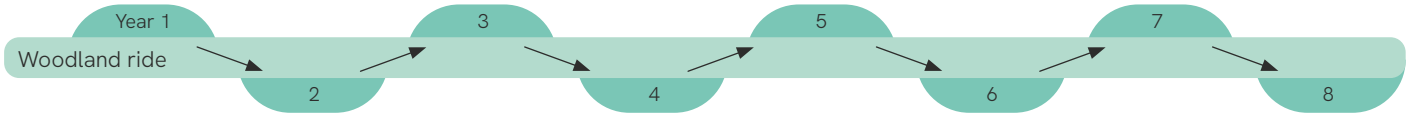
Two examples of scallop positioning and cutting regimes[1]

Parallel cutting regime (with opposite facing scallops) This regime will benefit species which prefer a particular aspect. At the end of each cycle, the regrowth at one side of the ride will be at a far more advanced state than the other.



Linear cutting regime (with offset scallops) This regime creates a far more varied habitat. At the end of each cycle, the regrowth at one end of the ride will be at a far more advanced state than the other.



1. Woodland edge habitat for butterflies: https://butterfly-conservation.org/sites/default/files/woodland-scallop-factsheet.pdf.

Woodland continued

Pests and disease

Action	Impact	Approx. cost (/MW,/ha, etc.)
Familiarise yourself with the tree species you have on your site in woodlands, hedgerows and tree lines. Learn to identify common tree diseases, and signs of stress and pests, such as ash dieback and horse chestnut leaf miner[1]. Oaks are in decline due to environmental stresses like soil conditions, drought, waterlogging and pollution. Invertebrates, fungi and bacteria then move in on the vulnerable tree and push it into decline. Have your trees surveyed annually by a reputable arboriculturalist, or if you are concerned about their condition.	Keeping a close eye on your trees will help to identify pests and diseases early, preventing them from spreading to other trees. Catching diseased and pest-ridden trees will help prevent them from becoming unstable and reduce the risk of harm to assets and health and safety of employees on site.	**NO COST**

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Non-native invasive species control and eradication

Action	Impact	Approx. cost (/MW,/ha, etc.)
Non-native invasive species (NNIS), such as rhododendron, can become problematic in woodland if left unmanaged. Due to their ability to grow and spread fast, non-native invasive species outcompete more slow-growing native species by blocking out the light and reducing nutrient availability. This reduces habitat heterogeneity and consequently, biodiversity. Rhododendron require manual removal from the root to eradicate, which could take years. Clearance work can be undertaken by volunteers or an arboricultural contractor, depending on budget.	Removal of rhododendron from woodland will let in light and create space for flowering plant species to establish in the understory. This will provide nectar for pollinators.	**NO COST or MEDIUM COST – from £15,500 per survey and £500 p/day**

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1. Tree pests and diseases: https://www.woodlandtrust.org.uk/trees-woods-and-wildlife/tree-pests-and-diseases/key-tree-pests-and-diseases/.

Woodland continued

Enhancement

Action	Impact	Approx. cost (/MW,/ha, etc.)
Veteranisation is a process carried out to increase the amount of dead wood/old tree-like habitats for wildlife. Treatments vary from notching nest boxes and woodpecker hole into trunks, to sawing off lower branches and removal of tree bark. It is a technique appropriate for sites where there is a large age gap between the ancient trees and the next generation. It is also important to ensure as a priority that there are enough trees that will have the opportunity to grow old naturally. Veteranisation has often been used as an alternative to felling trees, which would otherwise have to be removed because they are shading the ancient trees. Veteranisation is never appropriate for veteran or ancient trees and must be undertaken by a qualified arboriculturalist.	The process creates hollows, dead areas within the tree trunk and increases sap flow to attract wildlife and help create thriving environments for protected or threatened species[1].	**MEDIUM COST – from £15,500 per survey and £500 p/day**

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Treatment – broken branch

Saw off the lowest live branch which is at least 10cm in diameter. Cut the branch 20cm from the trunk, cut halfway through from the top and then pull/push the branch to rip it the rest of the way. Cut the remaining part to look like a natural fracture.

Example of a broken branch

1. https://www.woodlandtrust.org.uk/media/1798/wood-wise-ancient-trees.pdf.

Woodland continued

Connecting and expanding woodland

Action	Impact	Approx. cost (/MW,/ha, etc.)
Heavily fragmented woodland and isolated stands of trees can slowly be joined up by planting the right trees, for the region, in strategic locations on a site[1]. This can be achieved by in-filling with new whips where trees have died off or have been unsuccessful, or to connect habitats. Trees need to be planted about 2m apart, but you can plant them 1-5m apart depending on your space and plan. Wavy lines look more natural than regimented rows of trees[2]. Tree guards need to be installed to protect whips from deer grazing. Ideally, biodegradable tree guards should be installed around whips, if this is not possible, tree guards should be removed when the tree has established and outgrown the guard. Trees species selection is very important; trees planted should be suited to the soil conditions and region. Planting more drought tolerant species should also be considered due to increasing global temperatures as a result of climate change. Understory species should also be considered when expanding woodland environments.	Connecting fragmented woodland habitat to other patches of woodland, stands of trees, scrub and hedgerows will help species, such as hedgehogs and dormice to disperse and improve their distribution. This will increase the resources and mating opportunities available to these species. Having a mix of old and new trees on a site builds diversity and resilience into the woodland.	**MEDIUM COST – from £15,500 per survey and £500 p/day**

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1. Tree planting advice: https://www.woodlandtrust.org.uk/plant-trees/advice/.
2. How to plant a tree guide – The Woodland Trust: https://www.woodlandtrust.org.uk/plant-trees/advice/how-to-plant/.

Woodland continued

Fordie Estate woodland

Example of good tree planting practice: Slit planting

This is a simple method that is suitable for bare soil and grass. It can be easier than pit planting if you've got stony soil.

Step 1

Press your spade all the way into the ground, then push it forwards to create a slit. Make sure it's deep enough for the tree roots.

Step 2

Keep the slit open with your spade and place your tree inside with the root plug about 2cm below ground level.

Step 3

Remove the spade and push the soil back around the tree.

Step 4

If using tree guards or spirals to protect your saplings, this is the stage to add these. Press the protection firmly into the soil.

How to plant a tree guide – The Woodland Trust: https://www.woodlandtrust.org.uk/plant-trees/advice/how-to-plant/

Woodland continued

British native trees: growth rates and soil preferences (from Agate, E. 2002)

				Soil type					
Common name	Species name	Maximum height (m)	Growth rate	Wet ground	Light sandy soil	Heavy soil	Acid	Alkaline	Ok in shade
Alder, common	*Alnus glutinosa*	25	fast	●				●	●
Ash	*Fraxinus excelsior*	40	medium	●	●	●		●	●
Aspen	*Populus tremula*	18	fast			●	●	●	
Beech	*Fagus sylvatica*	40	medium		●	●			●
Birch, downy	*Betula pubescens*	25	fast	●			●		
Birch, silver	*Betula pendula*	26	fast		●		●		
Cherry, bird	*Prunus padus*	30	medium		●			●	
Crab apple	*Malus sylvestris*	10	slow		●	●	●	●	
Elm, wych	*Ulmus glabra*	40	medium			●		●	●
Hawthorn	*Crataegus monogyna*	15	slow		●	●	●	●	
Hawthorn, midland	*Crataegus laevigata*	10	slow			●		●	●
Hazel	*Corylus avellana*	6	fast			●		●	●

https://www.woodlandtrust.org.uk/media/1761/keeping-rivers-cool.pdf

Woodland continued

British native trees: growth rates and soil preferences (from Agate, E. 2002)

				Soil type					
Common name	Species name	Maximum height (m)	Growth rate	Wet ground	Light sandy soil	Heavy soil	Acid	Alkaline	Ok in shade
Holly	*Ilex aquifolium*	15	slow		●	●	●	●	●
Hornbeam	*Carpinus betulus*	30	medium	●		●		●	●
Lime, small-leaved	*Tilia cordata*	32	medium			●		●	●
Maple, field	*Acer campestre*	26	medium			●		●	●
Oak, pedunculate	*Quercus robur*	36	medium	●		●		●	
Oak, sessile	*Quercus petraea*	43	medium	●	●	●	●		●
Poplar, black	*Populus nigra var. Betulifolia*	32	fast	●	●	●		●	
Rowan	*Sorbus aucuparia*	20	fast		●		●		
Whitebeam, common	*Sorbus aria sensu lato*	25	medium		●	●		●	
Wild service	*Sorbus torminalis*	20	medium			●		●	●
Willow, crack	*Salix fragilis*	25	fast	●				●	
Willow, white	*Salix alba*	25	fast	●				●	●

https://www.woodlandtrust.org.uk/media/1761/keeping-rivers-cool.pdf

Woodland continued

Review of woodland management plan

Action	Impact	Approx. cost (/MW,/ha, etc.)
It may be that woodland on site has a game bird rearing (e.g. pheasants) agreement/rights attached to it. The presence of pheasants on site can have a negative impact on reptile and invertebrate populations. The predation of reptiles by pheasants has been observed for at least 200 years[1]. Pheasants are also predators of invertebrates and affect local populations. It is advisable to cease game rearing on sites and remove all game rearing agreements from the land as soon as possible. This may require further negotiation with stakeholders.	Removing game bird rearing will help the reptile and invertebrate populations recover to restore balance to the woodland ecosystem on site. Thus, help protect native species of conservation value such as grass snake and slow worm.	**MEDIUM COST – Depends if the agreement was non-financial. Maybe solicitors' fees involved**

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1. Moubray, B. (1816). A practical treatise on breeding, rearing, and fattening all kinds of domestic poultry, pheasants, pigeons, and rabbits (2nd edn). London: Sherwood, Neely and Jones.

Soil

Fertility management

Action	Impact	Approx. cost (/MW,/ha, etc.)
There should be no need to use fertilisers on site. Any grassland should be managed to reduce soil fertility via a cutting or grazing regime.	Prevents fertilisers leaching into the water course through surface water run-off or into the ground water supply through soils, causing eutrophication. Reduced soil fertility and increases plant diversity.	**NO COST**

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Aeration and porosity

Action	Impact	Approx. cost (/MW,/ha, etc.)
Avoid driving heavy vehicles off designated tracks to prevent soils from becoming compacted. Heavy grazing of livestock with a high stocking density for long periods of time can lead to compacted soils, which prevent water from percolating, causing run-off and erosion.	Increases the soil's capacity to retain water and to supply oxygen to plant roots. Prevents soil erosion, which can impact water quality.	**NO COST**

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Soil continued

Moving and handling

Action	Impact	Approx. cost (/MW,/ha, etc.)
Should soils need to be disturbed on site, the DEFRA Construction Code of Practice for the Sustainable Use of Soils on Construction Sites should be adhered to[1]. Topsoil and subsoil should be stockpiled separately, and handling kept to a minimum. Do not stockpile soils when wet. Cover or seed them to protect against erosion. Do not move soils when waterlogged or during heavy rainfall.	Soils remain healthy, run-off and erosion are prevented.	**NO ADDITIONAL COSTS**

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Carbon sequestration

Action	Impact	Approx. cost (/MW,/ha, etc.)
Try not to disturb soil unless absolutely necessary. To prepare ground for sowing seeds, shallow harrowing, minimum tillage or scarifying is advised, instead of ploughing.	Carbon in soil is locked away in the top 10 to 20cm. Keeping soil disturbance to a minimum will keep carbon locked in, reducing emissions.	**NO COST**

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1. Construction Code of Practice for the Sustainable Use of Soils on Construction Sites (publishing.service.gov.uk).

Water management

Rivers in the UK are under threat from pollution from agriculture, industry, urban development and transport, mining and domestic waste. Only 14% of the UK's rivers are considered to be in good ecological health and fail to meet required chemical standards[1]. A shocking 75% of UK rivers pose a serious risk to human health[2], despite being regulated under the Water Resource Act 1991[3].

The decline of healthy river systems in the UK has had a direct impact on native wildlife that depends on this freshwater ecosystem to thrive. An example of this has been observed with a national decline in the water vole (*Arvicola amphibious*) population.

Water voles are mammals that live along rivers, streams and ditches, around ponds and lakes, and in marshes, reedbeds and areas of wet moorland. They used to be found in nearly every waterway in England, Scotland and Wales but are now thought to have been lost in up to 90% of these sites[4]. Threats include habitat loss and fragmentation from unsympathetic riverside management, predation by non-native American mink and pollution[5]. Water voles are now listed as endangered on both the Great Britain and the England Red List for Mammals[6].

Water management on site is essential to maintain healthy river systems and reduce the risk of flooding. Poor land management and degraded soils can lead to soil erosion, causing surface water run-off and pollution pathways. An excess of nutrients in a water system causes algal blooms (algae) which use up all the oxygen in the water, leaving none for other aquatic life such as fish. Creating areas on site where water can pool naturally or percolate will increase water storage capacity, slow the flow of surface water run-off and help sediment to drop out before it joins the watercourse. This will help improve overall water quality in the catchment.

Where there is water, there is life! The presence of a pond or watercourse on site will attract wildlife and help improve overall biodiversity on site. If a site has a watercourse running through it, the land manager has responsibility to reduce impact on it and maintain good water quality. Neglecting to do so could lead to prosecution and fines from the Environment Agency[7].

There is no need to install an expensive, large pond that requires lots of maintenance. Ditches, swales and scrapes require minimum maintenance, but are just as effective. Creating water features on site in the form of wetland scrapes, ponds or ditches will attract a plethora of wildlife. It will very quickly become a haven for aquatic invertebrates such as pond skaters and dragonflies, which will in turn attract birds, amphibians, reptiles and mammals.

Historically, ditches have been used in agriculture to irrigate the land and drain wetlands for farming. There are over half a million kilometres of ditches in the British landscape[8]. Ditches provide standing water and vegetation for amphibians and aquatic invertebrates, such as frogs and dragonflies. Seasonal dryness of ditches is beneficial to invertebrates as it supports them at different stages in their lifecycle. Vegetated ditches help to drain and filter surface water run-off, which will improve the quality of water entering the catchment.

Water vole
(Arvicola amphibious)

1. https://theriverstrust.org/about-us/news/how-healthy-are-our-rivers.
2. https://www.sas.org.uk/water-quality/water-quality-facts-and-figures/.
3. https://www.legislation.gov.uk/ukpga/1991/57/contents.
4. https://ptes.org/get-informed/facts-figures/water-vole/.
5. https://www.wildlifetrusts.org/wildlife-explorer/mammals/water-vole.
6. https://www.iucnredlist.org.
7. https://www.gov.uk/topic/environmental-management/water.
8. Ditches and scrapes | WWT.

Water management continued

Invasive non-native plant and animal species are also a serious threat to freshwater ecosystems in the UK. Aquatic plant species, such as floating pennywort (*Hydrocotyle ranunculoides*) and New Zealand pygmyweed (*Crassula helmsii*), are extremely invasive species which are not easy to control. New Zealand pygmyweed can reproduce from a fragment of the parent plant and can easily be spread on clothing or equipment (e.g. cars, boats, fishing equipment, clothes) or by animals. It forms dense mats on water bodies that shade out other aquatic vegetation, consequently having a negative impact upon fish and invertebrate communities. These mats of vegetation can impede drainage and lead to flooding, reduce the amenity use of the affected waterbody and outcompete other aquatic vegetation. Severe oxygen depletion can also occur in the water under dense growths of this plant[1].

The signal crayfish (*Pacifastacus leniusculus*) is a North American species of crayfish. It was introduced to Europe in the 1960s to supplement the North European crayfish (*Astacus astacus*) fisheries, which were being damaged by crayfish plague, but the signal crayfish turned out to be a carrier of that disease. Crayfish plaque is a fungal disease, which can also be spread by wet footwear and equipment, therefore care should be taken to prevent it being spread between sites.

The UK's native crayfish have been depleting in numbers over the last 30 years as a result and are now a protected species[2]. The signal crayfish is now considered an invasive species across the UK and Europe.

Other invasive plant species, such as Japanese knotweed, Himalayan balsam and giant hogweed, thrive in riparian habitat. Their prolific seed or rhizomes enter the watercourse, making waterways a conduit for rapid seed dispersal. They outcompete native plant species, reducing biodiversity. Management of aquatic and terrestrial invasive non-native species (INNS) should be included in a site management plan.

The invasive signal crayfish *(Pacifastacus leniusculus)*

1. https://nnnsi.org/invasive-non-native-species/new-zealand-pygmyweed/.
2. https://canalrivertrust.org.uk/enjoy-the-waterways/canal-and-river-wildlife/canal-and-river-invasive-species/signal-crayfish.

Wetlands, ponds and ditches

Water quality testing

Action	Impact	Approx. cost (/MW,/ha, etc.)
If you have a watercourse running through your site, sign up to a local water quality monitoring scheme in your area and regularly check the water quality. Enquire with the local Rivers Trust[1] for more information. You can also purchase a water quality testing kit online for pH, phosphate, temperature, conductivity and turbidity and follow the instructions on the kit. Monitor at the same time every month in a downstream and upstream of the site boundary, or erosion hot spots.	Identify pollution pathways from your site into the water course and stop it at the source.	**LOW COST – from £20 to £50 for a testing kit**

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Seasonal/ephemeral water features

Action	Impact	Approx. cost (/MW,/ha, etc.)
Existing water features on a site will naturally go through a cycle of seasonal drying. With ditches and scrapes, the impact of seasonal dryness is obvious, causing them to dry out during the summer months; such water features are referred to as ephemeral. In the case of large ponds or lakes, water storage will be permanent all year round, with seasonal drying causing only minor fluctuations in water depth, exposing margins and banks. Ephemeral features require little maintenance, but can infill with vegetation, detritus and woody debris over time. Annually checking of water features is advisable. This will ensure the habitat is maintained. If removing material from a water feature, lay out to dry and for invertebrates and amphibians to escape. The dry material can be added to a hibernaculum. Where ground gutters have been installed on a site, these will also require an annual check for debris.	Ephemeral ditches, ponds and wetland scrapes creates essential habitat to support invertebrates at different stages of their lifecycles. This attracts birds, amphibians and small mammals, providing essential resources. Scrapes provide areas of bare ground, which may be designed to hold water in wet habitats or provide early successional areas in dry habitats. Ground gutters provide shallow channels to hold/transport water through wet habitats and provide feeding areas for waders.	**NO to LOW COST – £60 – £70 p/day**

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1. https://theriverstrust.org/.

Wetlands, ponds and ditches continued

Ponds

Action	Impact	Approx. cost (/MW,/ha, etc.)
A well-established pond should not require a lot of maintenance, as it will be naturally maintained by the pond life that live in it[1]. New ponds, however, will not host the pond life that helps regulate it yet. Some vegetation can be invasive and may need some of the weed removing if it has taken over. Pond weed can be removed using a net or pole. Do not clear more than a third in any one year and leave weeds/plants by the side of the pond to allow aquatic invertebrates and amphibians which live there to escape to the remaining foliage. Leaves and detritus can be removed during the autumn/winter in the same way. Algal blooms can take over a pond too, which can indicate increased nutrient content in the water, hot weather, low water levels or inadequate water circulation. An increase in nutrients can be caused by leaching of fertilisers from the soil into surface water run-off. If your pond has an algal bloom, barley straw can be added to the pond in netted bags. A chemical reaction between the straw and algae slows down the growth of new algae, and as a result, unable to replenish itself, it slowly dies naturally. If the pond is experiencing dramatic water loss it might be that the pond liner is leaking and needs repair. Minor loss is normal and can be topped up with rainwater. Do not use tap water. Planting native marginal plants, such as marsh marigold, will help oxygenate the water.	Managing invasive weeds and algal blooms will help maintain the ponds natural processes. Removal of leaves will help prevent the pond from becoming stagnated. A healthy pond will attract a plethora of wildlife, including lots of birds.	**NO COST or LOW COST – £15.50 p/hr manual labour**

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1. Pond Care | Wildlife Pond Maintenance Guide – The RSPB.

Wetlands, ponds and ditches continued

Riparian buffer strips

Action	Impact	Approx. cost (/MW,/ha, etc.)
Maintaining areas of species-rich grassland along riverbanks (known as riparian buffer strips) is essential if there is a watercourse present on site. This will help to stabilise riverbanks, prevent erosion and reduce the amount of silt entering the river. Managing existing trees along a riverbank to provide a mix of light and shade (dappled light) will provide refuge for aquatic wildlife[1]. If in doubt, hire a professional arboricultural contractor to undertake any pruning required. Tree work should be conducted outside of nesting bird season, which runs throughout March to August.	Maintaining riparian buffer strip will help slow the flow of surface water, increases infiltration and help prevent soil, sediment and nutrients entering the watercourse.	**NO COST to LOW COST – £65 – £90 p/day for pruning** **LOW COST – from £47.50 to £60 p/hr for field margins**

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Example of a riparian buffer strip

1. Riparian buffer strips: https://theriverstrust.org/our-work/farm-advice/best-practice-advice-sheets-for-farmers.

Plug planting at Foresight solar site

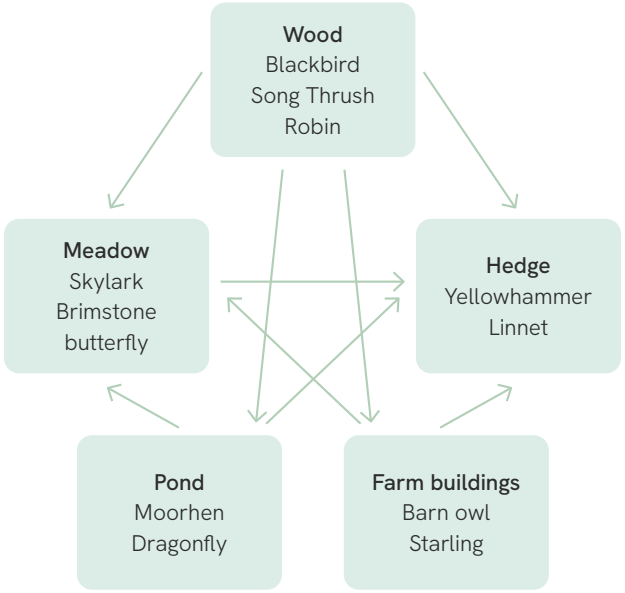
5. Proactive interventions and initiatives

In this section:

Proactive interventions and initiatives

This section highlights the proactive habitat enhancements that can be implemented on sites rather than altering current management regimes included in the previous section.

Many species use more than one habitat to complete their lifecycle[1]



Solar farms provide a unique opportunity to increase biodiversity on site due to being undisturbed all year round and having a low footfall. The use of patterns of light and shade provided by solar arrays could help reptiles and invertebrates control their temperature more effectively.

In some instances, a variety of vegetation, substrate and localised variation in topography has inadvertently been created when the solar farm was established. This variation of habitat type, such as mix of scrub, rough grass, open water, bare ground or exposed gravel/lifecycle aggregate, creates a mosaic effect that can be extremely diverse; supporting a wide range of terrestrial and aquatic habitats at different stages in their lifecycle.

All habitats, such as woodland, grassland, hedge and pond, are interrelated because most species require more than one habitat either to complete their lifecycle or thrive throughout the year.

Dragonflies, for example, not only need the pond, but also require hay meadows as much of their prey will be attracted to the nectar of wildflowers. Other invertebrates, such as bees and butterflies, need bare ground in addition to nectar-rich meadows to complete their lifecycle. Bare ground provides nesting sites for solitary bees and wasps, ants and beetles, basking areas for butterflies and flies, and hunting ground for beetles[2].

If invertebrates are thriving, then it's likely that many other species are too. Invertebrates are good indicators of a healthy environment and provide the following ecosystem services:

- Pollination of crops and wildflowers and other plants
- Pest control
- Essential food for birds and mammals like hedgehogs, bats and shrews
- Soil enrichment
- Breakdown of waste, such as fallen leaves, carrion, decaying timber, dung and soil residue
- Enjoyment to people[3]

There are some proactive interventions that can be made on site to increase biodiversity at very low or no cost. This could be as simple as repurposing waste substrate into a bee bank that would have been mucked away or leaving standing dead wood and piling it up to create a refuge for overwintering amphibians and reptiles.

Some interventions can be more substantial, such as creating an invertebrate bank, pond or planting a woodland. Interventions that have a bigger impact on the landscape may require a survey and/or permission prior to work commencing. Therefore, it is best practice to check with the local statutory body. Careful consideration and planning should be given to the location of any large-scale intervention. If in doubt, seek advice from the local ecology consultancy or Wildlife Trust beforehand.

1. Flower, C., 2008. Where Have All The Wildflowers Gone, UK.
2. https://defrafarming.blog.gov.uk/create-areas-of-bare-ground-for-invertebrates/.
3. https://defrafarming.blog.gov.uk/create-areas-of-bare-ground-for-invertebrates/.

Invertebrate banks

Butterfly banks

Action	Impact	Approx. cost (/MW,/ha, etc.)
Butterfly banks are areas of varied ground in grassland habitat, e.g. a mix of vegetation and bare ground on unshaded south-facing banks. Low fertility ground is ideal as the ideal conditions require sparse habitat. This can be created by removing areas of topsoil or burying it using soil inversion to create a mounded C shape in lengths up to 50m long, 10m wide, 30cm. Earth moving machinery is recommended for this. The top of the mound can be seeded with a wildflower mix and lower ground scraped back to provide bare earth that can be covered in chippings. Butterfly banks are well suited to areas of land at the edges of the solar array providing different zones – areas with longer vegetation for shelter and feeding (nectar) and areas with short sparse vegetation for breeding. Maintaining these different areas is important, especially the bare ground. Brush cutting half the bank at a time every other year is an effective and easy way to achieve variation in vegetation height[1].	This kind of bank should provide the right kind of breeding habitat for rare butterfly and moth species such as: grizzled skipper, chimney sweeper moth, small copper, six spot burnet moth, common blue, dingy skipper and brown argus. It is important to baseline assess an area before carrying out earth works to ensure you are not damaging any existing valuable habitat or archaeological site.	**LOW COST – £60 to £70 p/day**

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1. https://butterfly-conservation.org/sites/default/files/2024-01/Butterfly%20Bank%20Factsheet_FINAL.pdf.

Invertebrate banks continued

Bee banks

Action	Impact	Approx. cost (/MW,/ha, etc.)
Similar to butterfly banks, bee banks can be created by building crescent shaped mounds on sunny south-facing sheltered spots. They can be big or small, scattered across a site or clustered together. The C shape helps to trap warmth and create a transition of conditions that will also benefit other invertebrates. Sources of nectar such as wildflower patches will also provide feeding sites. Using 30cm of builders sand as a cap for a bee bank allows bees to dig their burrows easily. Added biodiversity value can be created by installing dead wood stumps with holes drilled in them, or bundles of canes/perennial plant stems, to provide nesting opportunities for leafcutter and mason bees[1].	Solitary mining bees benefit from warm bare ground where they can nest. Over time encroaching vegetation will need to be managed, but areas should be cleared in alternating sections to minimise disturbance.	**LOW COST – sand £65 to £85 depending on quantity** **Labour using hand tools £15.50 p/hr**

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Bumble bee on Devil's bit Scabious

Species rich grassland

1. https://butterfly-conservation.org/sites/default/files/2024-01/Butterfly%20Bank%20Factsheet_FINAL.pdf.

Invertebrate banks continued

Beetle banks

Action	Impact	Approx. cost (/MW,/ha, etc.)
Beetle banks are permanent raised grassy mounds in sunny spots where the grass is allowed to grow long all summer and cut back in the autumn. They have been used at farm scale cross arable fields, but they can be created in any suitable spot large or small (though ideally at least 1m long). The grassy mound can be created using seed or turf, but the aim is to allow the grass to create both sunny and shady habitat. You can create beetle banks in the winter to sow with seed in the spring or carry out all the work in one go in the spring. Ideal seed mixes include a mix of species such as: • Tussocky grasses – cock's-foot, timothy, meadow fescue, tall fescue • Tall grasses – sheep's fescue, common bent, red fescue • Wildflowers – yarrow, oxeye daisy, wild carrot, teasel, common knapweed, red campion[1] Beetle banks can take a couple of years to establish and should be maintained to prevent dominant species taking over. A diversity of vegetation type and height is needed.	Beetle banks provide habitats during the winter for beetles and spiders and in the summer, they will help control crop pests such as aphids. Beetle banks also provide habitat for other mammals and birds and can help to manage flooding, run-off and soil erosion.	**LOW COST – Labour using hand tools £15.50 p/hr** **Wildflower and grass mix £12 p/100g**

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1. https://defrafarming.blog.gov.uk/create-and-maintain-beetle-banks/.

Wildflowers and species-rich grassland creation

Wildflowers are essential for a healthy environment. They provide pollinators and other invertebrates with food from leaves, pollen, nectar, shelter and places to breed. Pollinators then return the favour by transferring pollen from flower to flower, enabling the wildflowers to develop seeds that produce more flowers. Wildflowers are also beneficial during the winter as food is scarce in the countryside and wildflower seeds become an important food source for birds and small mammals.

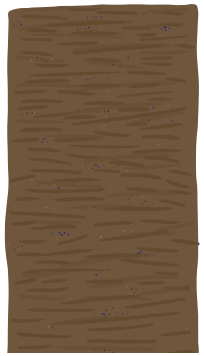
However, the benefits extend beyond their flowers to below the surface. Established wildflower meadows and species-rich grassland have very stable soil due to the complex root systems formed by wildflowers. This allows the soil to handle heavy rainfall, preventing erosion and losing nutrients to the nearest watercourse.

Any area of species-rich grassland or wildflowers are beneficial, big or small, but sowing the right wildflower mix that suits the soil type and location is important. Wildflowers do very well in nutrient-poor soil, as there are less weeds for them to compete with. Topsoils are typically rich in nutrients and contain a weed seed bank that will quickly take over and prevent wildflowers from establishing. It is best to sow wildflowers into bare ground, ideally subsoil. If this is not an option, there are other ways to prepare the ground and get good results. These are outlined below.

Wildflower meadows/species-rich grassland will need managing through a cut and collect regime or grazing to help them establish. It can take up to five years to start seeing a difference in diversity, but it will be worth it. Without any intervention it would soon start to become scrub, bramble and trees.

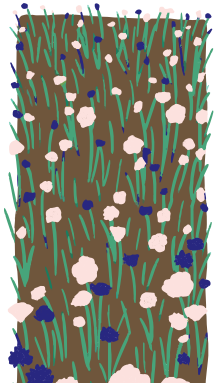
Example of meadow succession from Year 0 to Year 7 onwards[1]

Year 0:



Re-seeding of species-poor grassland

Year 1:



- Sparse-dominant yellow rattle
- Few perennial meadow wildflowers
- High levels of annual wildflowers (e.g. cornfield annual wildflowers, if sown in a mix with perennial wildflowers)

Year 2-4:

- Sparse-dominant yellow rattle
- Medium-high legumes including bird's-foot trefoil, red clover, common vetch and tufted vetch

Year 4-6:

- Sparse-dominant yellow rattle
- Medium-high oxeye daisy with buttercups

Year 7 onwards:

- Sparse-medium yellow rattle
- Flowers and grasses start to settle with the grassland, becoming more diverse over time as more perennial plants start to develop
- Some plants may take more than seven years to establish
- The sward starts to look more like a natural hay meadow after 10 years but may take many more to reach the full potential

Year 1: cornfield annuals (cornflower, corn marigold, corn poppy, corn chamomile), perennials germinating below

Year 2: fewer cornfield annuals and some perennials larger and flowering (yellow rattle, wild carrot, oxeye daisy)

Year 3: more perennials and almost no cornfield annuals (more yellow rattle and less dominant grasses, wild carrot, oxeye daisy, meadow buttercup, cowslip, field scabious, betony, selfheal)

Year 4 to 6: all perennials – more natural diversity occurs as soil fertility decreases, start getting things like orchids, fine grasses, fungi

Years 7 to 10: flowers and grasses start to settle with the grassland and become more diverse over time. Sward height starts to look like a natural hay meadow

1. Adapted from: http://www.magnificentmeadows.org.uk/assets/pdfs/Wildflower_restoration_succession_FINAL.pdf

Wildflowers and species-rich grassland creation continued

Semi–improved grassland and margins

Action	Impact	Approx. cost (/MW,/ha, etc.)
To create semi-improved grassland, consider over-sowing an existing area of poor/modified grassland. Prior to starting, ensure that you comply with EIA (Agriculture) Regulations, if changing land equal to or above 2 hectares[1]. To prepare an existing area of poor/modified grassland for over-sowing, disc, chain, or power harrow to create 60% bare ground, and over-sowing with an appropriate wildflower mix. Over-sowing can be done by hand, drill, green hay or broadcaster, depending on what resources are available. The seed is then rolled in to ensure contact is made with the bare ground. Margins around occupied areas can be sown in the same way. Where ground is bare directly after solar arrays have been installed, this provides a great opportunity to sow a wildflower and grass mix directly into bare ground. To create a seed bed, soil needs to be cultivated to a fine tilth, sown and rolled. It is best to sow wildflower seeds in autumn, when the ground is cooling and wildflower seeds would naturally drop. They are also less likely to need watering. In addition to seeding, wildflower plug plants can be used to fill in any sparse areas.	Create more diverse and species-rich grassland with flowering plants to attract pollinators, a variety of other insects, and birds. Helps store carbon and reduce the impact of surface water run-off.	**LOW to MEDIUM COST – from approx. £1,000 p/ha or from £400 p/acre**

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1. EIA (Agriculture) Regulations: apply to make changes to rural land – GOV.UK (www.gov.uk).

Wildflowers and species-rich grassland creation continued

Yellow rattle

Action	Impact	Approx. cost (/MW,/ha, etc.)
Create patches of bare ground in areas of lower diversity pasture/ modified grassland using a rake or strimmer. Over-sow yellow rattle (*Rhinanthus minor*)[1] into the bare ground and roll to ensure contact is made. For best results, sow in the autumn with fresh seed collected the same year.	Yellow rattle is an annual that thrives in grasslands, living a semi-parasitic life by feeding off the nutrients in the roots of nearby grasses. Nicknamed "the meadow-maker", it is often used to turn modified (improved) grassland back to meadow – by feeding off the vigorous grasses and weakening their impact, it eventually allows more delicate, native wildflower species to compete.	**NO COST or LOW COST – groundwork contractor from £15.50 p/hr**

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Solar meadow mix (under solar arrays)

Action	Impact	Approx. cost (/MW,/ha, etc.)
Conditions under solar arrays provide variation in light/shade and soil moisture. This presents a unique opportunity to sow a selection of wildflower species that are tolerant of variations in environmental conditions. Ideally, wildflower seed would be sown into bare ground (subsoil) when solar arrays are installed, to give them the best chance to establish successfully. However, it is possible to create areas of bare ground using a hand rake or harrow and over-sow, as described above. Sowing yellow rattle is also an option, as this will infiltrate to lower diversity pasture/modified grassland. Examples of suitable wildflower species under solar arrays include: primrose, yarrow, field scabious, ribwort plantain, birdsfoot trefoil, bugle, nettle-leaved bellflower.	Growing wildflowers that are tolerant of changes in environmental conditions that occur under solar arrays will increase species richness, attract a variety of insects, and utilise space on a site.	**Wildflower seed ranges from £20 to £70 per 100g depending on species**

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1. https://www.wildlifetrusts.org/wildlife-explorer/wildflowers/yellow-rattle.

Wildflowers and species-rich grassland creation continued

Priority species

Action	Impact	Approx. cost (/MW,/ha, etc.)
Find out what priority habitat and species are under threat within a 2km radius of the site from a PEA or conduct your own desktop survey (see baseline surveys for more information). Contact your local butterfly and bee conservation group for local records. Use the information to create a wildflower mix to support specific pollinators that may be threatened or in decline and could potentially utilise the site (e.g. devils-bit scabious is the food plant of choice of the marsh fritillary butterfly). Create a ground nesting bird area outside the footprint of the array, which is managed for birds that require unbroken sightlines. Area size and management will depend on the species and numbers targeted.	Creates and connects habitat for threatened species or those in decline. Can help contribute to local Nature Recovery Networks and regional species recovery targets.	**LOW to MEDIUM COST – bespoke seed mix from £90 to £350 per/kg depending on species mix**

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Woodland edge and understorey

Action	Impact	Approx. cost (/MW,/ha, etc.)
Sowing a woodland edge or woodland wildflower mix will help provide nectar for pollinators that prefer sunny woodland edges and glades, such as butterflies. Sow along woodland edges or understorey that are clear of scrub or exposed to light. The wildflower mix should be made up of native species, such as wild garlic and English bluebell. These will take a few years to establish if sown from seed. Plugs can be planted to give them a head start. Examples of wildflowers suitable for woodland/woodland edge: wild angelica, wood avens, wild garlic, bluebell, primrose, red campion, foxglove, garlic mustard.	Provides habitat for woodland edges species, such as butterflies.	**LOW COST – woodland seed mix £12 p/100g** **Labour £15.50 p/hr**

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Hedgerows

Creation

Action	Impact	Approx. cost (/MW,/ha, etc.)
If planting a single hedge, place your trees 30cm apart. For a thick hedge, plant a double row of trees in a zigzag pattern. Space your rows 50cm apart, with 40-45cm between each tree. Between four and six plants per metre should be planted. Minor species can be planted in small single species groups or randomly within larger blocks of hawthorn. Notch plant bare-rooted stock, insert the supporting cane approx. 25cm into the ground, alongside the plant, and wrap the clear spiral guard around both the plant and the cane. Pit plant holly and protect with tree tube and supporting stake.	Hedgerow habitats are corridors for wildlife to live and commute. Increased access to resources and mating opportunities for wildlife will support and help to expand biodiversity.	**MEDIUM COST – from £23 p/m**

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Enhancement

Action	Impact	Approx. cost (/MW,/ha, etc.)
Hedges can be kept bushy for many years by cutting them occasionally, but eventually they will become open at the base. If this happens, they need to be cut down close to ground level so they can send up a crop of new stems and begin a fresh cycle of healthy growth. If you have room, big mature trees, especially native ones like oak, ash and beech, will increase the amount of wildlife that uses the hedge dramatically.	Invertebrates will congregate around the crown and beneath the canopy, providing rich feeding for birds and bats. Small trees, like holly, rowan and crab apple, are also very valuable, especially for their flowers and rich berry and fruit crops. Many creatures avoid crossing open spaces because it makes them vulnerable to predators. If your hedge is linked to other hedges, or to a woodland or pond, it will provide safe passage for wildlife to move through both rural and urban landscapes.	**LOW COST – tree whips from 20p to 60p depending on species. Plus £15.50 p/hr labour**

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Hedgerows continued

Dormouse nest boxes

Action	Impact	Approx. cost (/MW,/ha, etc.)
A PEA should tell you if dormice are present locally and if the site has potential for dormice. If so, sign your site up to the People's Trust for Endangered Species (PTES) hazel dormouse nest box and monitoring scheme[1]. Download, complete and return the form on the PTES website and they will provide nest boxes at £5.00 per box plus a £12.50 delivery cost per 20 boxes. Or follow their online guide on how to make a nest box. Please note inspecting dormouse nest boxes requires a licence from Natural England or Natural Resources Wales in areas where dormice are either already known to be present or if their presence is likely.	Installing dormice nest boxes into the hedgerow will encourage them to move in, if they have been recorded in nearby woodlands or on site.	**LOW COST – from £5.00 p/nesting box**

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Dormouse in next box
Photo credit: Laura Snell

1. Hazel dormouse nest box scheme: https://ptes.org/campaigns/dormice/hazel-dormouse-conservation/hazel-dormouse-nest-boxes/.

Boundary features

Boundary features (e.g. tree line, stone walls, scrub and verges)

Boundary features are beneficial to wildlife by acting as corridors, 'wildlife corridors' is any linear feature in a landscape that can be used for the migration or dispersal of species. Corridors link habitats, allowing species to move freely and reducing the possibility of populations becoming isolated. How many times a corridor is fragmented by gaps in walls etc. affects its functionality as an effective corridor. As our habitats in the UK have become increasingly fragmented, landscape scale connected corridors have become more and more important.

Tree planting, stone walls, scrub and verges

Action	Impact	Approx. cost (/MW,/ha, etc.)
Plant trees in verges along access routes and in hedgerows. Turf or vegetate top of stone walls where bare and in-fill with new stone walling where they may have failed. Soften edges of ditches with marginal grassland. Leave verges uncut for a season to see what flowering plants come up. Leaving areas of scrub uncut during nesting bird season will provide nesting and roosting sites, and foraging opportunity.	Provides more diverse habitat on site for wildlife. Stone walls provide overwintering opportunity for amphibians and reptiles. They also provide habitat for invertebrates at different stages of their lifecycle.	**LOW COST – tree whips from 20p to 60p depending on species. Plus £15.50 p/hr labour**

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Woodland

Creation

Action	Impact	Approx. cost (/MW,/ha, etc.)
If a site is deemed suitable for creating woodland, have the site surveyed by a suitably qualified ecologist or arboriculturalist to determine if creating woodland habitat is feasible. Seek advice on designing new woodland to fit within the landscape and accommodate features of interest. New woodland creation may be eligible for a grant from the Forestry Commission. If you want to create a new woodland without grant support from the Forestry Commission you may, depending on the size and location of the proposed project, need to submit a 'stage 1' forestry Environmental Impact Assessment (EIA) application[1]. To get regulatory approval and grant funding for your project, your woodland creation design plan must comply with the UK Forestry Standard[2].	Creating woodland habitat will store carbon, provide habitat for wildlife, connect hedgerow and lines of trees with each other and the wider landscape.	**LOW COST – tree whips from 20p to 60p, plus £15.50 p/hr labour for smaller areas, depending on species, or from £500 p/acre**

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1. Information on woodland creation grant: https://www.gov.uk/guidance/tree-planting-and-woodland-creation-overview.
2. Forestry Standard for woodland creation: https://www.gov.uk/government/publications/the-uk-forestry-standard.

Woodland continued

Hibernacula

Action	Impact	Approx. cost (/MW,/ha, etc.)
Create a hibernaculum for overwintering wildlife, such as amphibians[1]. Stack felled dead wood and rocks into piles along woodland edges, scrub, near pond edges or hedgerows (where it does not pose a risk to Health and Safety or assets). Top with leaf litter, grass cuttings and/or arisings to increase the ambient temperature in the pile.	Provides optimal conditions for overwintering mammals, reptiles and amphibians, and provides habitat for invertebrates at different stages in their lifecycle (e.g. nursery for beetle larvae). Provides foraging opportunity for birds and other animals all year round.	**NO COST to LOW COST – £15.50 p/hr labour if not in-house**

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Hibernacula

Example of a simple hibernacula for overwintering wildlife.

1. How to make a simple hibernacula https://www.froglife.org/info-advice/wintering-sites-or-toad-homes/.

Woodland continued

Bird boxes

Action	Impact	Approx. cost (/MW,/ha, etc.)
Buy or make a nest box out of an old pallet or reclaimed wood[1], erect 2m to 4m up a tree or wall. The entrance hole size depends on the species you hope to attract: • 25mm for blue, coal and marsh tits • 28mm for great tits, tree sparrows and pied flycatchers • 32mm for house sparrows and nuthatches • 45mm for starlings The small box with 100mm high open front may attract robins or pied wagtails. A wren would need a 140mm high front panel, while spotted flycatchers prefer a low 60mm front to the box. A breeding bird survey of the site will determine what species are present and would benefit from additional nest boxes.	Provides instant safe, warm and dry nesting site for passerines, such as blue tits, sparrows or starlings.	**NO COST to LOW COST – £15.50 p/hr labour if not in-house**

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Bird box

1. https://www.rspb.org.uk/birds-and-wildlife/advice/how-you-can-help-birds/nestboxes/nestboxes-for-small-birds/making-and-placing-a-bird-box/.

Woodland continued

Bat boxes

Action	Impact	Approx. cost (/MW,/ha, etc.)
Buy or make a bat box out of an old pallet or untreated and unplanned, reclaimed wood[1]. Wooden bat boxes are usually cubic or rectangular, with a grooved 'bat ladder' and a narrow entrance slit at the bottom. They can be nailed to trees or walls, 4-5m high, in a sheltered spot that receives sun during the day. Bats prefer well insulated, draught-free boxes that maintain a constant temperature and humidity. Adding a 'bat ladder' or other landing area that leads to an entry slit wide enough to admit bats, but narrow enough to keep out predators, is also essential, usually 15-20mm. Once up, a bat box cannot be opened legally without a licence. If you find a sick or ailing bat, you should not approach or handle the animal – please call the Bat Conservation Trust's bat helpline.	Provides instant safe, warm and dry roosting site for bats.	**NO COST to LOW COST – £15.50 p/hr labour if not in-house**

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Bat box

1. Bat box guidance: https://www.bats.org.uk/our-work/buildings-planning-and-development/bat-boxes.

Soil and substrates

Carbon sequestration

Action	Impact	Approx. cost (/MW,/ha, etc.)
Soils store carbon and a lot of it, but soil is prone to erosion if left bare or disturbed regularly. Create, restore and mange habitat on site, such as woodland or species-rich grassland, for carbon storage. This can be achieved by planting trees and extending existing woodland (if present on site), creating species-rich grassland and managing existing grassland for wildflowers. It might be possible to earn income for the woodland creation by selling carbon credits from the project. This requires registration with the Woodland Carbon Code within two years from the start of planting[1].	Species-rich grassland, heathland, wildflower meadows and woodland not only provide habitat for wildlife, but also lock in carbon. Creating, restoring and managing these habitats on site in the long term will help protect this essential ecosystem service that soil provides.	**LOW to MEDIUM COST – from £400 to £500 p/acre**

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1. Woodland Carbon Code: https://www.gov.uk/guidance/the-woodland-carbon-code-scheme-for-buyers-and-landowners.

Soil and substrates continued

Bare ground

Action	Impact	Approx. cost (/MW,/ha, etc.)
Create or expose areas of sand, waste aggregate, stone piles, gravel and bare ground using existing site won substrate for nesting and foraging invertebrates. You can create bare ground in any location with good sunlight, such as south-facing slopes, or edges of woodlands, tracks and paths. Lightly compacted sand or clay soils are best for solitary bees and wasps. The soft surfaces help them to burrow easily. Bare ground is easy to create. You can do this with machinery like a small excavator, or by hand with a spade. Individual areas do not need to be large. Work should be undertaken in the autumn and winter, when invertebrates will not be nesting. To attract the widest range of invertebrates, you should: • Create several patches in a variety of shapes and locate the patches in different areas across the site • Clear any vegetation that is shading the patches • On flatter areas you can create several small mounds up to 1m high, with south-facing curved edges[1] Annual management may be required if areas become shaded or vegetated. Clear vegetation manually and avoid using heavy machinery to avoid damaging nest sites. It might be easier to manage half the area one year and half the next, so there is always suitable habitat.	Having different substrates and areas of bare ground creates a mosaic of habitats that can support invertebrates at different stages in their lifecycle. Lots of solitary bees and wasps using the areas and butterflies basking in the sun.	**NO COST if using site won material and in-house labour, or LOW COST – aggregate from £80 for a bulk bag of aggregate, plus labour £15.50 p/hr**

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1. Bare ground creation for invertebrates: https://defrafarming.blog.gov.uk/create-areas-of-bare-ground-for-invertebrates/.

Wetlands, ponds and ditches

Creation

Before creating a wetland feature on site, the following factors should be considered:

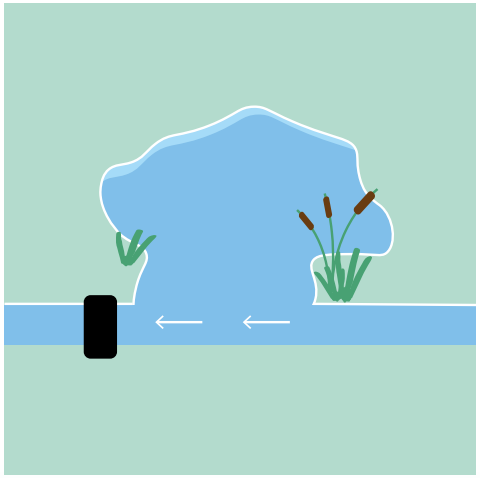
- Soil type
- Size of site
- Land levels and topography
- Water sources and quality
- Existing land drainage systems and drain locations
- Existing flora and fauna, SSSI designations and archaeological/landscape features

It is advisable to seek advice from an ecologist or local Wildlife Trust prior to installing a water feature. Creating water-retaining features such as scrapes may require consents, licences or permissions. Consult with the relevant statutory body at an early stage, which may be able to provide advice and help with your project.

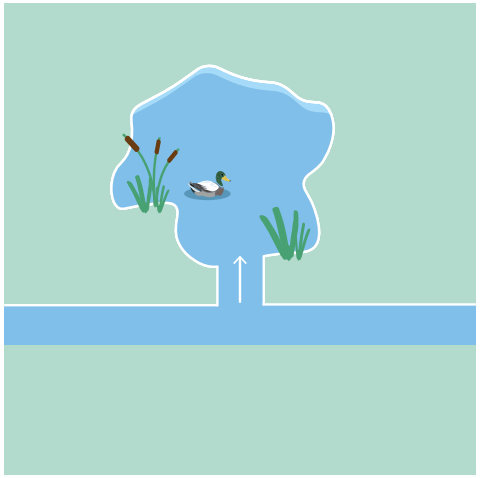
Example of wetland scrape design[1]

A simple scrape design

A cluster of scrapes is better than one large one



A scrape created on a ditch line



A scrape connected to a water source

1. https://community.rspb.org.uk/ourwork/farming/b/farming-blog/posts/the-all-nature-benefits-of-wader-scrapes.

Wetlands, ponds and ditches continued

Wetland scrapes

Action	Impact	Approx. cost (/MW,/ha, etc.)
Wetland scrapes are shallow ponds, less than 1m in depth, which hold rain or flood water seasonally but stay damp for most of the year[1]. They do not require a liner and are very low maintenance. Identify areas on site that are naturally wetted for longer periods of the year, such as areas of damp or floodplain grassland. These often occur in lower-lying areas at the bottom of slopes or shaded areas in the corner of fields. Scrapes should be shallow and non-uniform with sloping edges. Do not fence the scrape off. Once the scrape is created, it is important to maintain open, muddy margins where wading birds can find and access food. If the margins become too overgrown with plants such as rush, wader use will decline rapidly. If livestock is an option, allow to graze and poach the margins at low levels. If not, mowing all, or some of, the margins each year may also be required. Maintain a small proportion of longer marginal vegetation to provide additional habitat variety, which will benefit invertebrates and plants and provide cover for chicks.	Scrapes are extremely valuable to wildlife, especially attracting wading birds. The shallow water, muddy edges and varied marginal vegetation provided by wetland scrapes support a plethora of wetland invertebrates. Damp areas, such as scrapes, also contribute to wildflower-rich grassland.	**LOW to MEDIUM COST depending on size – from £500 to £5,000+**

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1. Natural England,. (2010). Natural England Technical Information Note TIN079: Illustrated guide to ponds and scrapes. First edition 12 November 2010. https://www.gov.uk/government/organisations/natural-england

Wetlands, ponds and ditches continued

Ponds

Action	Impact	Approx. cost (/MW,/ha, etc.)
Assess the site for areas where water naturally pools or floods, ideally in a sunny spot. A pond can be created at any time of the year, but starting autumn or late winter will help the pond to establish quicker[1]. Mark out the pond on the ground using string or rope. Depending on the size of the pond, dig manually using a spade or for larger areas, use an excavator. Graduate and soften pond edges by creating gently sloping banks and shallow shelves for wildlife to access easily. Spoil from the pond can be used to create earth banks around the pond to protect it from the cold and east winds. These can be planted with shrubs and seeded with rough grass as ground cover for overwintering amphibians, such as newts. Remove any sharp stones and line the pond with sand. If the soil is naturally high in clay a liner may not be required. If not, lay a butyl liner over the sand. Bentonite clay liners are also available. Fill the pond with rainwater. Back fill around the edges of the pond as it fills, as the liner will stretch. Make sure that the liner is not exposed as it will deteriorate quickly in UV light. Create a soft transition zone around the pond using rocks and native marginal plants, such as marsh marigold and yellow flag iris. A beach can also be created for passing birds such as wagtails and migrating waders by laying geotextile underlay along an area of shoreline with a layer of 20mm gravel on top. Seed the periphery with a wildflower pond edge mix. If planting submerged or oxygenated pond plants and floating pond plants, choose native and non-invasive species[2]. Some pond weed can take over a pond and reduce the oxygen content in the water.	A wildlife pond is one of the best features for attracting new wildlife to a site. Having oxygenating plants will remove any need for a pump system and provide essential habitat for aquatic invertebrates.	**MEDIUM COST – £500 to £5,000 depending on size**

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1. Pond creation guidance: https://www.wwt.org.uk/discover-wetlands/gardening-for-wetlands/how-to-build-a-wildlife-pond/.
2. Pond plant guidance: https://www.wwt.org.uk/discover-wetlands/gardening-for-wetlands/a-guide-to-native-pond-plants/.

Wetlands, ponds and ditches continued

Riparian buffer strips

Action	Impact	Approx. cost (/MW,/ha, etc.)
For damper areas, select a wildflower and grass mix that will tolerate wetter conditions, such as a wildflower wetland mix or pond edge mix. These mixes are ideal for riparian buffer strips along a stream or watercourse (between 4-12m away from the bank). Planting trees as part of a riparian buffer strip will also help to stabilise riverbanks, helping to prevent erosion and reducing the amount of silt entering the river. The trees also shade rivers, keeping them cool for aquatic wildlife[1]. Examples of wetland wildflowers: cowslip, devil's bit scabious, ragged-robin, wild carrot, meadow buttercup, meadowsweet and water avens.	Species selected will tolerate damp conditions and establish quickly. A riparian buffer strip will help slow the flow of surface water, increase infiltration and help prevent soil, sediment and nutrient entering the watercourse.	**MEDIUM COST – £400 to £500 p/acre**

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Devil's bit scabious

Devil's bit scabious seed drying

1. Riparian buffer strips: https://theriverstrust.org/our-work/farm-advice/best-practice-advice-sheets-for-farmers.

Sustainable drainage systems

Sediment traps, bunds and swales

Action	Impact	Approx. cost (/MW,/ha, etc.)
Assess the site for areas prone to surface water run-off, which can cause sediment to enter the watercourse. For sediment ponds or traps (less than 25 square metres), excavate to an appropriate depth and create gently sloping banks. Spread any excess soil thinly across the land, away from the excavated pond area. For larger sediment ponds or traps (greater than 25 square metres), follow the requirements set out in the Feasibility Study (PA2)[1] or CSF design plan (Water-Holding Feature Management Plan). Do not place soil on any historic or archaeological feature or wildlife area identified on the FER, the Environmental Information Map or the HEFER. Ensure that all work meets relevant British Standards – examine copies of the most up-to-date standards for guidance.	A sediment pond or trap will provide an area where muddy run-off from fields or tracks is allowed to pool so sediment will settle out. This will help reduce the risk of sediment and other pollutants entering a nearby watercourse.	**MEDIUM COST – from £10 to £100 p/m² depending on type**

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Pond transition (creating SDS alternative)

Action	Impact	Approx. cost (/MW,/ha, etc.)
Graduate and soften existing pond edges by creating gently sloping banks and shallow shelves[2]. This can be done manually with hand tools on small ponds or with an excavator on larger areas. Place rocks around the edges of the pond and plant with marginal pond species or seed with a pond edge wildflower mix.	Gently sloping edges and marginal vegetation will help establish a transition zone to grassland habitat. This will create a corridor for wildlife to commute and disperse more easily through the landscape, and help amphibians find overwintering sites.	**LOW to MEDIUM COST – £100 to £1,000+ depending on area**

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1. PA2: Feasibility study – GOV.UK (www.gov.uk).
2. Ponds and Wetlands.indd (cambridge.gov.uk).

Solar Shotwick

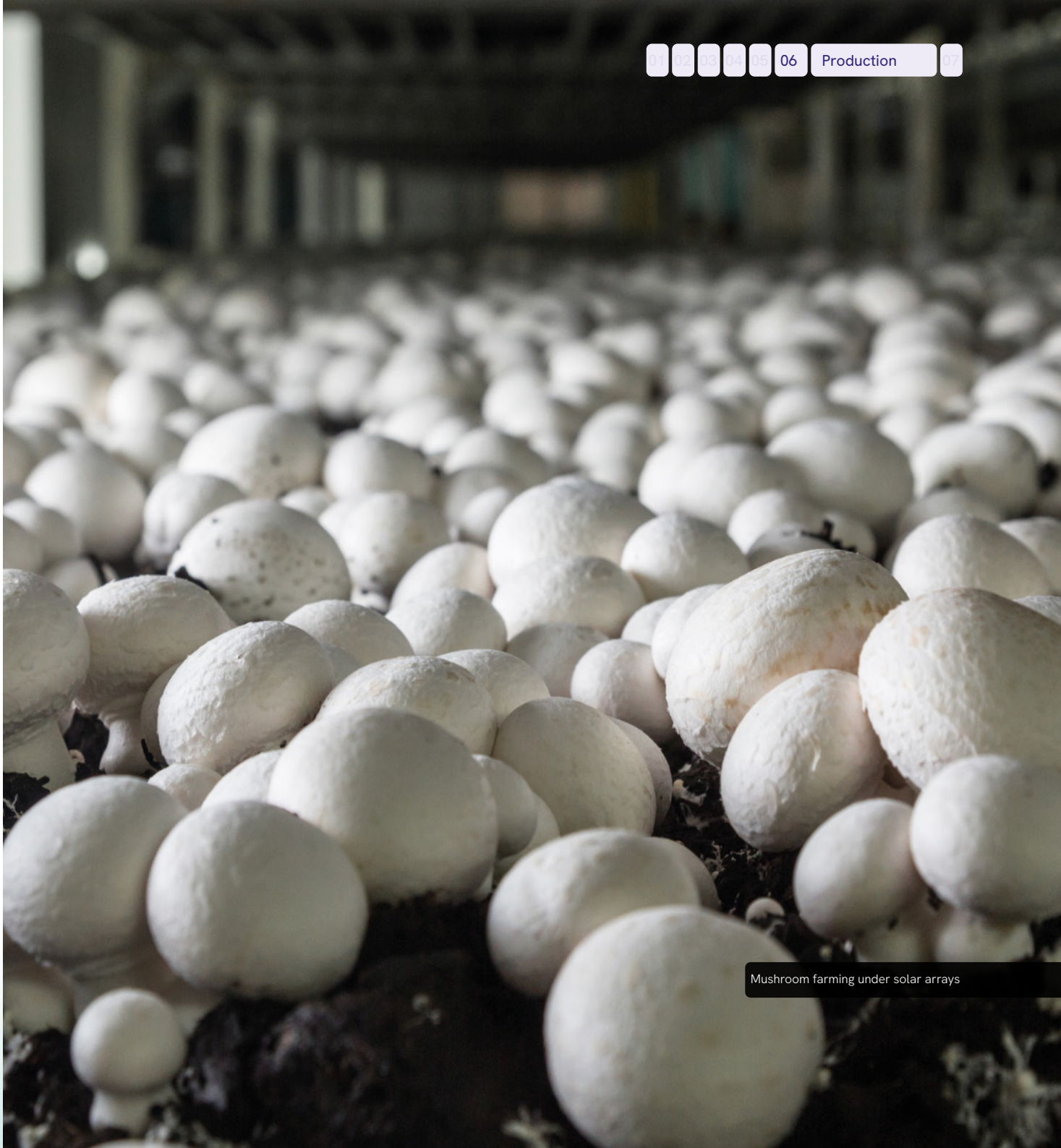
6. Interventions for agricultural goods

In this section:

Additional operational considerations

Prior to any agricultural goods being planted or established on site, consideration needs to be given, some examples of common considerations are below.

- Lease terms – are there any specific lease stipulations and/or planning restrictions which may prevent the establishment or planting of any agricultural goods?
- HSE – ensure that the addition of any agricultural goods on site does not compromise the operations or safety of the site, personnel or local environment.
- Licensing – are there any licencing requirements for the crops to be grown in the area and if the plan is to sell the produce are there are restrictions around this?
- Ongoing management – who is going to be attending the crops and the management of these, and how will they access site on an ongoing basis.



Mushroom farming under solar arrays

1. Ponds and Wetlands https://www.cambridge.gov.uk/media/5462/suds-design-and-adoption-guide-part-5.pdf.

Planting at Foresight Solar Site

Agrivoltaics

Agrivoltaic farming is the practice of growing crops underneath solar panels. Scientific studies[1] show some crops thrive when grown in this way. Doubling up on land use could help feed the world's growing population while also providing sustainable energy. As world leaders prepare to gather at COP27 amid a global energy crisis, climate change and renewables are sharply in focus. At the same time, increasing climate resilience across food systems will be needed to counter rising hunger and malnutrition, according to UN General Assembly President, Abdulla Shahid.

Agrivoltaic farming could be a solution to not just one, but both of these problems. It uses the shaded space underneath solar panels to grow crops. This increases land-use efficiency, as it lets solar farms and agriculture share ground, rather than making them compete against one another.

However, the way in which agricultural practices are managed on a site will determine the contribution these interventions can make to nature recovery. More recently, we have seen the rise in popularity of regenerative agriculture, a form of production that improves the environment primarily by looking after the soil. In a regenerative system the soil is left relatively undisturbed and covered as much as possible with crops or stubble, where appropriate, roots are left in the ground (dependent on crop), crop diversity is encouraged and grazing animals are used on multispecies leys (a piece of ground put down to grass to allow the land to rest for one or more years between productive years)[2].

Regenerative farming is good for nature because it restores and mimics natural processes which provide benefits for wildlife through reduced pesticides and herbicides and increased plant diversity[3].

1. Scientific research into growing crops under solar arrays: https://www.mdpi.com/2073-4395/12/6/1415/htm#B4-agronomy-12-01415.
2. https://groundswellag.com/principles-of-regenerative-agriculture/.
3. Nature positive farming: https://community.rspb.org.uk/ourwork/b/nature-s-advocates/posts/nature-positive-farming-series-nature-friendly-farming-supports-food-security.

Agrivoltaics continued

Mycoculture

Action	Impact	Approx. cost (/MW,/ha, etc.)
In Japan, they grow mushrooms in racks under solar arrays[1] due to the humid and dark conditions that are created. There is scope to do this in the UK.	Efficient use of space to produce food, carbon offset by grassland on site, profitable and highly productive. Shade and humidity provide perfect conditions.	**MEDIUM to HIGH COST – £1,500 to £10,000+**

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Forage

Action	Impact	Approx. cost (/MW,/ha, etc.)
Growing fodder crops for livestock, such as grasses, legumes and brassicas, is a good use of space on solar farms. A farm share or tenancy agreement would be required. Land access, soil type and conditions, and Health and Safety would need consideration.	Efficient use of space to produce food, carbon offset by grassland on site, profitable and highly productive. Shade is provided and less water is required.	**£244 to £487 p/ha depending on fodder crop**

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1. Example of mushroom growing under solar arrays in Japan: https://www.fastcompany.com/40469425/these-solar-farms-have-a-secret-hiding-under-them-mushrooms.

Agrivoltaics continued

Crop plants

Action	Impact	Approx. cost (/MW,/ha, etc.)
In Colorado, USA, crops are being grown between solar arrays[1]. Suitable crop suggestions are (but not exclusive to): • Wild garlic • Carrots • Kale • Tomatoes • Garlic • Beetroot • Radishes • Lettuce • Broccoli Researchers in South Korea have been growing broccoli underneath photovoltaic panels[2]. The panels are positioned 2-3m off the ground and sit at an angle of 30 degrees, providing shade and offering crops protection from the weather. An agrivoltaic farm enterprise[3] would need to be discussed at the land requisition stage of a new solar farm or at renewal of a contract with the landowner. A farm share or tenancy agreement would be required. Land access, soil type and conditions, and Health and Safety would need consideration.	Efficient use of space to produce food, carbon offset by grassland on site, profitable and highly productive. Shade is provided and less water is required.	**MEDIUM to HIGH COST – £1,500 to £10,000+**

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1. Agrivoltaics Colorado https://www.wired.com/story/growing-crops-under-solar-panels-now-theres-a-bright-idea/#:~:text=The%20farm%20is%20growing%20a,electricity%20to%20power%20300%20homes.
2. World Economic Forum article on agrivoltaics: https://www.weforum.org/agenda/2022/07/agrivoltaic-farming-solar-energy/.
3. Agrivoltaics https://www.agritecture.com/blog/2022/2/3/largest-farm-to-grow-crops-under-solar-panels-proves-to-be-a-bumper-crop-for-agrivoltaic-land-use.

Agrivoltaics continued

Orchards

Action	Impact	Approx. cost (/MW,/ha, etc.)
Orchards[1] are areas of trees and shrubs planted for food, usually fruit. They are an historic habitat; many species of fruit tree were brought over by the Romans and cultivating fruit trees might date back to the Neolithic period. Orchards can be established either under solar arrays[2] or outside the footprint of the solar arrays. Planting an orchard takes planning, the following must be considered prior to starting: location, size of area, soil type, water availability and variety of fruit trees. 1. Draw a plan and set it out with canes. 2. Prepare a hole at least 30% larger than the tree's existing root system requires: this will avoid creating a basin in which water collects and ensures the roots have a friable medium to grow into. 3. Consider using mycorrhizal fungi – available as a powder or gel – to develop a beneficial network of mycorrhiza that promote root and plant development. 4. Use a low stake; this secures the roots from being pulled over, leaving the upper tree to flex and develop resilience. 5. Install a tree guard to prevent rabbits removing the bark around the base. A tree is vulnerable, early on mulching for one yard around the base removes grass competition, helps retain water and suppresses weeds. Water when you plant and then regularly throughout the first 18 months. Once a tree is established, consider planting wildflower plugs around the base that will attract early pollinators and the beneficial invertebrates, as well as helping to minimise mowing.	Not only do orchards provide local produce for sale to the local community, but they can also be hugely beneficial to wildlife. They are perfect for pollinators, and fruit trees age quickly, which creates essential deadwood habitats for invertebrates. This will in turn provide food and shelter for birds.	**Approx. £20 per tree**

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1. Orchards https://www.woodlandtrust.org.uk/trees-woods-and-wildlife/habitats/orchards/#:~:text=Orchards%20are%20areas%20of%20trees,also%20be%20important%20for%20wildlife.
2. Orchard established under solar arrays in Germany https://www.euronews.com/green/2022/09/01/solar-panels-provide-shade-and-a-second-source-of-revenue-for-this-enterprising-german-far.

Apiculture

The practice of co-locating solar farms and pollinators, both honey bee apiaries and wild pollinators, through managing sites as species-rich grasslands, makes sense. With large-scale solar farm growth accelerating globally, now is a good time for companies to review and implement a programmatic approach to ensure their sites deliver to both the climate and ecological emergencies, and society's needs[1]. However, it's best practice to check with the local Bee Keeping Association on whether the location is suitable before introducing honey bees. This is due to issues with dominance over bee species by honey bees in some areas of the country.

Hives

Action	Impact	Approx. cost (/MW,/ha, etc.)
Engage with local beekeepers or community beekeeping groups to discuss co-locating beehives on site. Opportunity to install thermosolar beehives, a new beehive design that uses passive solar gain to elevate the internal hive temperature. This kills off the varroa parasite and leaves the bees unharmed. It also, importantly, avoids the use of any chemicals.	Introducing honeybees into solar farms is the perfect catalyst to significantly improve on-site biodiversity. The bees require food, which means more wildflowers, boosting natural capital/ecosystem services. Beehives may be operated by local community groups and the honey produced can be branded and sold locally which further reinforces the benefits of locally produced clean energy. As a result, local communities become more connected to both their energy and ecology[2].	**LOW COST – from £100 to £1,000 per hive**

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Beekeeping at Sandridge Solar Farm

1. https://fresh-energy.org/solar-beekeeping-goes-global.
2. https://www.naturesave.co.uk/naturesave-trust/solar-bee-project/.
3. https://www.wildlifetrusts.org/sites/default/files/2022-11/Certified%20Sites%20%281%29.pdf.

Photographer: Lorna Lyle

7. Access to nature

In this section:

Access to nature

Why is this important?

There is growing evidence that access to nature is good for human wellbeing as well as providing a valuable foundation for learning and research.

Solar sites are designed to ensure access is controlled for health and safety reasons and to protect an asset. However, with the correct planning there are still opportunities for access to be provided for the wider community if prepared for and managed well. Allowing access to sites for specific groups and purposes can create two-way benefits for both the business and external organisations and groups.

Basic requirements for managing people on site

All solar sites must adhere to strict health and safety protocols when allowing people on site. Appropriate risk assessments will need to be carried out. Why people are on site will affect the level of H&S protocols required and who might need to accompany them.

See below the main items that should be considered when drafting a risk assessment and methods statement for visitors to attend a solar site:

- Brief scope of work or visit for assessments
- Personal protective equipment
- Main contact person
- Site access and egress
- Induction
- Site-specific requirements – To be provided by O&M
- Site-specific risks – To be provided by O&M
- Emergency arrangements
- Welfare facilities
- Need for risk assessments, permissions checklist

Volunteer seed collecting

UK initiatives that could support nature recovery on solar sites

There are a range of environmental initiatives that could align with a nature recovery strategy for a solar site. There are opportunities to gain support for biodiversity monitoring, particularly if a site supports species in which these initiatives and organisations have a special interest in restoring. See below for some examples:

Local nature partnerships and the Nature Recovery Network

Local nature partnerships (LNPs) bring together businesses, local organisations and individuals who have an interest in improving their local natural environment. A map showing the areas they are responsible for can be found here[1]. Local nature partnerships were formed in response to the recognition that people needed to work in a more joined up and strategic way for the benefit of the environment. LNPs work towards delivering national environmental objectives locally by working with local authorities, enterprise partnerships and health and wellbeing boards.

More recently, many LNPs in England have been tasked with developing a Nature Recovery Network (NRN) as one of the major commitments in the Government's 25-year environment plan enacted by the Environment Act 2021.

The Nature Recovery Network will:

- enhance sites designated for nature conservation and other wildlife-rich places
- create and restore wildlife-rich habitats, corridors and stepping-stones that help wildlife populations to recover, grow, move, thrive and adapt to a changing climate
- improve the natural and urban environment's resilience to climate change, providing natural solutions to reduce carbon emissions and manage flood risk
- sustain vital ecosystems that provide healthy soil, clean water and clean air
- protect the natural, geological, historical and cultural diversity of the natural environment
- provide more, better green spaces for us to enjoy and connect with nature where we live, work and play, improving our health and wellbeing[2]

Nature Recovery Networks objectives include the creation and restoration of 500,000 hectares of additional wildlife-rich habitat outside of protected sites, an increase in woodland cover and achieving a range of benefits such as carbon capture, pollination and clean water. The Government wants to broaden the funding base for NRNs by encouraging private and third sector investment in the natural environment.

To support the development of the network, the NRN delivery partnership has been created, any sector who are willing to commit to nature's recovery can join the partnership, including private businesses. Partners are encouraged to pledge support by providing land for nature recovery, financial investment, time and expertise. Partners are given networking opportunities and access to a regular NRN conference, workshops and meetings[3]. To become a NRN delivery partner contact: **NDPNaturerecovery@naturalengland.org.uk.**

Botanical Society of Britain and Ireland (BSBI)

BSBI uses teams of professional and amateur botanists to carry out botanical surveys. Their network of volunteer county recorders is one of the world's largest contributors of biological records and is used to inform scientific research and underpin evidence-based conservation. This organisation produces extensive distribution maps which are useful in understanding changes to species populations and endorsing positive impact through nature recovery[4].

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2. https://www.gov.uk/government/publications/nature-recovery-network/nature-recovery-network.
3. https://www.gov.uk/government/publications/nature-recovery-network/nature-recovery-network#nrn-delivery-partnership.
4. https://bsbi.org/about-bsbi.

UK initiatives that could support nature recovery on solar sites continued

B-lines

B-lines is an initiative created by the charity Buglife to reverse the decline of pollinating insects. B-lines are a network of wildflower-rich habitats that seeks to repair our fragmented landscapes and to allow insects and other wildlife to move freely supported by continuous opportunities for nesting, breeding and feeding sites[1].

B-lines is a network of 3km-wide insect pathways connecting the best remaining wildflower-rich habitats across the whole of the UK. This initiative works with a diverse set of partners, including water companies, businesses, farmers, highways managers and local authorities. B-lines uses computer modelling to find the best routes to connect pollinator-friendly habitats, the data is freely available to anyone who is creating strategies for restoring nature networks. To find out if you are on or near a B-line, and if you can contribute, go to the interactive B-lines map: **www.buglife.org.uk/our-work/b-lines/.**

Butterfly Conservation

Butterfly Conservation uses experts and volunteers to record and monitor butterfly and moth populations across the UK. This organisation runs the United Kingdom Butterfly Monitoring Scheme, one of the longest-running insect monitoring schemes in the world and one of the most important resources for understanding changes in insect species populations. You can become part of the scheme by establishing new transects, recording a wider countryside butterfly square (WCBS) and undertaking reduced effort surveys. They offer guidance on monitoring and mechanisms for submitting your data to wider datasets to compare and contrast the impact of your nature recovery efforts. They also provide advice on health and safety including risk assessments, how to carry out transect surveys, WCBS and non-transect methods of monitoring and recording as well as practical training videos[2].

Royal Society for the Protection of Birds (RSPB) mapping and GIS

The RSPB records and hold datasets for birds including citizen science data and regional monitoring, you can access RSPB data through their Open Data Portal[3].

The RSPB Futurescapes programme supports landscape scale conservation initiatives. The programme works with landowners, particularly in their priority areas, to connect reserves using smaller pieces of land between them to help combat habitat fragmentation. This initiative is a way of making small nature recovery interventions part of something bigger.

Wildlife Trust

The Wildlife Trust will work with businesses and landowners who want to achieve the Wildlife Trust's Biodiversity Benchmark that certifies the management of your business or landholdings for wildlife. The Biodiversity Benchmark complements ISO14001 and has a set of specific requirements[4].

Academic partnerships

Universities and higher education institutions may be interested in partnering with sites to support research opportunities, especially relating to testing the effectiveness of different interventions or new technologies for monitoring particular species or habitats. Departments and courses relating to sustainability, ecological restoration, habitat management and conservation and renewable energy may all have interests in partnering with solar sites.

For example: the University of Exeter Applied Ecology Unit is currently supporting MSci research projects investigating plant pollinator interactions in wildflower habitats and Lancaster Environment Centre is working with the solar industry to assess the impact of solar parks on ecosystem services.

1. https://cdn.buglife.org.uk/2021/03/B-Lines-Report-DIGITAL-01.pdf.
2. https://ukbms.org/guidance-recording-forms.
3. https://opendata-rspb.opendata.arcgis.com/.
4. https://www.wildlifetrusts.org/sites/default/files/2022-07/BiodiversityBenchmarkRequirements.pdf.

Using nature recovery on solar sites to engage with wider communities

There are several ways in which solar sites can engage with people from other organisations through nature recovery by:

- Developing educational opportunities with higher education organisations by using sites as research sites for graduate, postgraduate or postdoctorate studies. For example, by providing opportunities for monitoring plant and pollinator interactions, specific species population monitoring, soil health or carbon capture
- Developing educational or monitoring opportunities for special interest or friends of groups to carry out citizen science monitoring for specific species, e.g. butterflies, moths, bats, dormice or botanical surveys or undertaking wildflower seed collecting to maintain genetic integrity of seed supplies or help protect and restore rare species
- Developing educational opportunities for schools through school visits
- Using sites as demonstrators for innovative nature recovery techniques and providing training for land managers and contractors
- Developing professional development opportunities for staff by using nature recovery actions on sites as part of induction programmes and team building activities

Planting at Foresight Solar Site

Using nature recovery on solar sites to engage with wider communities continued

Community engagement and education – Verwood Solar Farm

Earth Energy Education (EEE) works with renewable energy project developers and asset owners and managers to facilitate school visits and workshops connecting schools to their local solar and/or wind farms. They have been working at Verwood Solar Farm in Dorset since 2014. The project developer, Solstice Renewables, included an educational programme to be delivered by EEE as part of the community benefits package with the planning application. EEE has worked with Belltown Power, the asset manager, to continue to deliver the programme since the solar farm was built.

Since 2014, 35 school groups have visited the site and a further 56 groups have had workshops. To date, 3,340 young people ranging from nursery to University have engaged with the project. Children who visited in 2014, in Year 6 at the time, would now be 19, ready to enter the world of work. Might this visit have influenced their next steps?

During site visits children learn about electricity generation and its route through the solar farm to their homes, as well as the materials involved and their properties. Visits are often accompanied by a solar engineer from the O&M company, providing an invaluable source of first-hand expertise. They also spend time looking at the ecology on the site and measuring the success of biodiversity measures. All learning is experiential and hands on where possible, connected to the climate and ecological crises and to the National Curriculum.

Nine years on and the Verwood school teachers are used to the objectives and procedures of the school visits and workshops. They use them as a topic starter to stimulate pupils' learning or as a topic finale to consolidate concepts. The solar farm has become firmly embedded into their curriculum.

"We have had an association with Verwood Solar Farm for many years. Through visits to the farm and their outreach with us, the children have been able to appreciate first hand how this is a vital resource for the community. They have learned about sustainable and renewable sources of energy and what they can do to help combat climate change in a very real and engaging way. Our relationship with the farm is invaluable; a long-term commitment has enabled us to design a curriculum that really meets the needs of our learners and allows opportunities to see the positive impact solar farms have on the environment. I would not hesitate to encourage other companies and schools to begin developing a relationship with Verwood Solar Farm."

Wimborne St Giles Headteacher 2019

During Covid, when site visits weren't possible, EEE created a film to show students what happens at a solar farm.

"We were given a premiere video of the solar farm as we were unable to attend the site due to Covid-19 restrictions. This was above and beyond what we were expecting, and the video was very professional. Being able to see the farm through the use of the video, as we were unable to visit, was fantastic."

North Mundham Primary School Teacher 2021

"I really enjoyed learning about the solar panels at the farm because it made me think about how I can save energy at my house!"

Year 4 Pupil, North Mundham Primary School 2022

Health and safety is a vital consideration prior to planning a visit to a solar farm. For each site considering hosting site visits, rigorous health and safety processes must be followed ensuring that the site is as safe as possible for visits. This includes ensuring that earthing reviews are up to date and regular maintenance is carried out and recorded with clear communication between site engineers and educational consultants. EEE provides comprehensive RAMS following a pre-visit to the site.

Photographer: Lorna Lyle

Using nature recovery on solar sites to engage with wider communities continued

Community engagement – Wildflower Warriors volunteers

The National Wildflower Centre at the Eden Project has developed a volunteer programme to support their programme of seed collection from the wild. Community members and staff are trained in seed collection processes and the programme is supported by a citizen science app that provides the right data capture tools and information to successfully identify wildflowers and collect seeds.

The information recorded in the database can also be shared with the national database managed by the Botanical Society of the British Isles.

Taking part in a Wildflower Warriors seed collection event gives people a chance to improve their wildflower identification and monitoring skills, learn something new, be part of a team and be outside with a purpose, which can be beneficial for health and wellbeing.

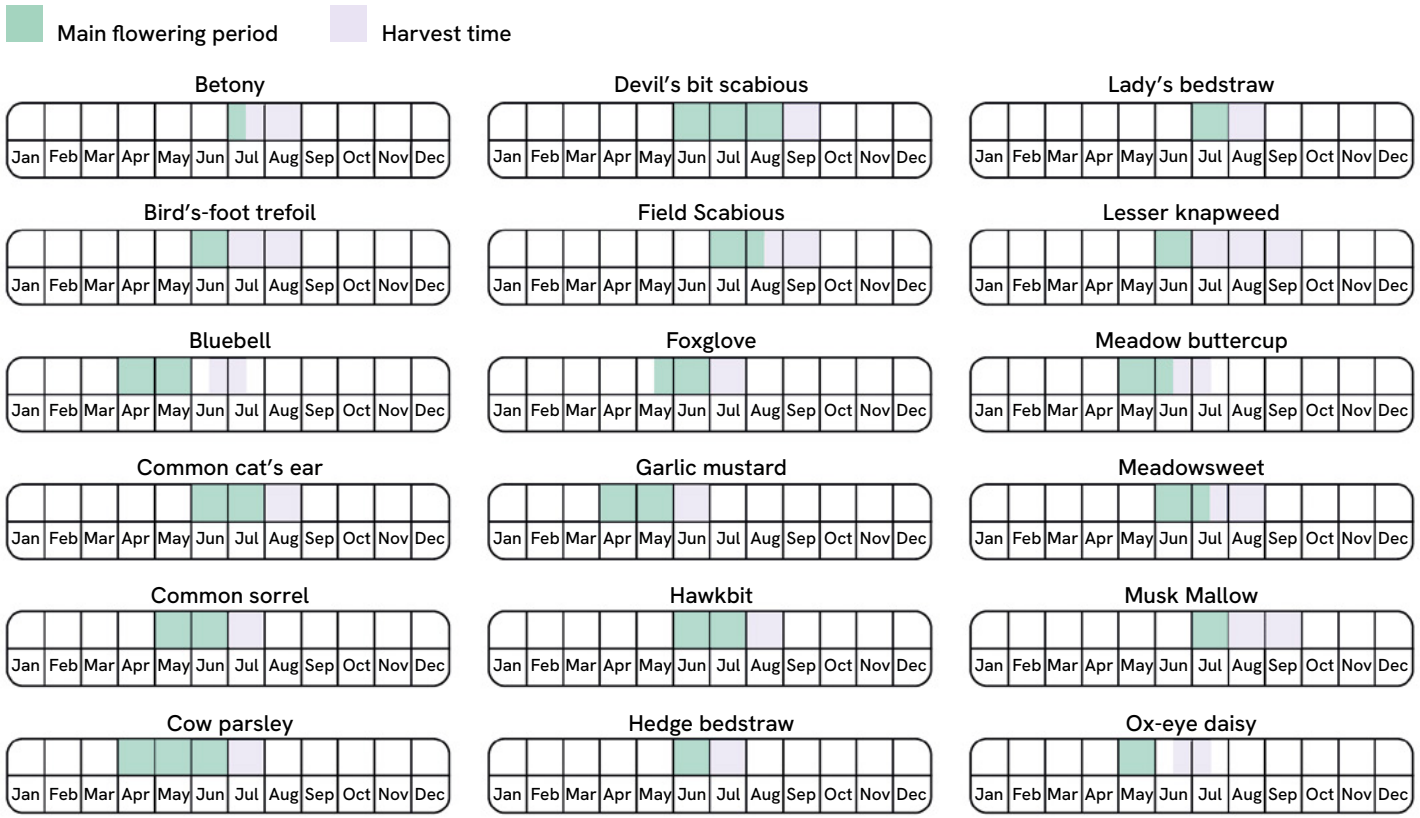
This activity is also helping to build a seed bank of local provenance seed that can be used to enhance other sites or establish new populations and contribute to regional nature recovery plans.

Spring, summer and autumn are the best times to undergo this activity with a trained facilitator, and all permissions and safety requirements need to be organised in advance, but this is a more participative process than a purely observational site visit. This kind of activity makes the most of the relatively undisturbed nature of solar sites, helping to establish them as refuges for species within the wider landscape.

See below for an example of a wildflower seed collecting calendar indicating some of the species that are collected by the National Wildflower Centre over the course of a year.

Photo credit: National Wildflower Centre

Seed calendar



Glossary

- **Abundance of species** – Number of a species within a given area.
- **Agronomist** – An expert in the science of soil management and crop production.
- **Amphibians** – A class of cold-blooded animal that includes toads, frogs and newts. They usually have an aquatic stage when young, such as tadpoles.
- **Arborticulturalist** – Someone who grows, manages and cares for trees, hedgerows and shrubs; including felling, planting or maintaining woody plants.
- **Baseline** – An ecological baseline is a sites ecological value before any development progresses and is compared to the ecological value after construction work.
- **Biodiversity** – A measure of how many different plant and animal species are present in a specific area. High biodiversity is important for healthy environments.
- **Biodiversity Net Gain (BNG)** – To increase the levels of biodiversity post-development when developing land to aid nature recovery.
- **Biodiversity Units (BU)** – The measure for biodiversity gains and losses resulting from a development, which is calculated depending on a habitats size and quality.
- **Botany** – Also called plant science, plant biology or phytology, is the science of plant life and a branch of biology. A botanist, plant scientist or phytologist is a scientist who specialises in this field.
- **Coppice** – An area of woodland in which trees or shrubs are cut back periodically to ground level to stimulate growth and provide firewood or timber.
- **Coupe (or cants)** – Coppice woodlands that are divided into sections which are cut 'on rotation'.
- **Ditch** – A thin channel dug beside roads or fields to hold or channel water, which can aid drainage or plant irrigation.
- **Ecology** – The study of how living creatures interact with each other and their environments to make up ecosystems.
- **eDNA** – A method to identify species present in an ecosystem using genetic analysis.
- **Extended Phase 1 survey** – A habitat survey that records the semi-natural vegetation and wildlife present over a large area of land. The survey can identify specific features of conservation importance, such as protected species, which could constraint development proposals.
- **Grassland** – An area of country continuously covered by grasses, which occur in environments that are not favourable to taller plants like trees.
- **Grazing** – Grassland that is suitable for cattle, sheep and other animals to feed on.
- **Ground gutter** – A trench dug around a building or in a wet location that can divert water away from the area.
- **Flagship species** – Indicate the presence of other species habitats and communities.
- **Habitat** – The natural home where an animal or plant lives.
- **Habitat Abundance** – The relative coverage of a particular habitat over an area.
- **Habitat integrity** – Ability to support and maintain a balanced, adaptive community of organisms that has a diversity of species and their function within an ecosystem.
- **Hedgerow** – Strips of woodland edge habitat of closely spaced shrubs and trees. They provide essential nesting and foraging areas for a variety of wildlife.
- **Heterogeneity** – A word that signifies diversity or variation of species.
- **Hibernacula** – The shelter that a hibernating animal sleeps in when dormant in winter.
- **Infertile soils** – Soil that has a low nutrient content (e.g. nitrogen and phosphorous).
- **Invasive Non-Native Species (INNS)** – A species that has been introduced to habitats outside their normal range by human activities and due to their competition, aggression or diseases now threaten native wildlife.
- **Invertebrates** – Animals that do not have a backbone, e.g. insects.
- **Monoculture** – A form of farming in which only one type of crop is grown across a field, such as a wheat field. These systems are particularly susceptible to disease.
- **Mosaic approach** – An approach that integrates species requirements within a site, such as access to places needed to reproduce, into habitat management. Different necessary elements, such as tall flower-rich vegetation and scattered trees, are introduced into landscapes to support species across their lifecycle and meet conservation targets.
- **Occupied grassland** – Grassland that is home to human populations and may be used for agriculture.
- **Phase 1 survey** – The first rapid habitat assessment performed on a site that measure plants present.
- **Pond** – A small, still, land-based body of water pooled in a depression which can attract wildlife.
- **Preliminary Ecological Appraisal (PEA)** – The same as an Extended Phase 1 habitat survey and used as the baseline ecology survey for a site considering habitats and protected species.
- **Protected species** – A plant or animal species protected by law that is illegal to damage or destroy.
- **Reptiles** – A group of cold-blooded vertebrate animals which includes snakes and lizards, marked by egg-laying and dry, scaly skin.
- **Resilience of ecosystems** – The ability of ecosystems to restore function following stress (e.g. drought).
- **Riparian** – Wetlands and banks adjacent to rivers and streams.

Glossary continued

- **Scrub** – A plant community dominated by shrubs, such as grasses and herbs. It can be the mature community in poor soil habitats but is often a "successional habitat" marking the transition from grassland to woodland.
- **Soil health** – An assessment of soil functions as a living ecosystem that can sustain plants and animals over time. Health is decreased by processes such as erosion.
- **Soil organic carbon (SOC)** – The carbon component of soil organic matter. SOC regulates key soil functions such as nutrient provision, water storage and drainage ability.
- **Soil resource survey** – Surveys which evaluate and quantify the soil resources present in a development site, and measures properties such as texture, drainage, erosion and pH.
- **Species** – A group of organisms made up of similar individuals able to reproduce and create fertile offspring that can also reproduce.
- **Species Abundance** – The number of individuals of a species present in an area, which combined with species richness can measure biodiversity.
- **Species richness** – The count, or total number of different species represented in an ecological community, landscape or region.
- **The Statutory Biodiversity Metric** – A tool developed by DEFRA used to calculate the Biodiversity Unit value of habitat pre and post-development.
- **The Statutory Biodiversity Metric: Condition Assessment** – A set of criteria used to determine the quality of a habitat type measured against its ecological optimum.
- **Survey** – Assessing a proposed development site to estimate the environmental impacts of developing the area.
- **Swale** – A low, marshy depression in a stretch of land that is usually moister and contains more vegetation than ditches.
- **Sward** – An expansive area of land covered with short grass.
- **Sward height** – The average height of grass in a field, which can help plan use of the land for grazing.
- **Tree Preservation Order (TPO)** – An order made by local planning authorities to protect specific trees, tree patches or woods which prevent cutting down, uprooting or any damage or destruction without their written consent.
- **UK Habitat Classification (UKHab)** – A simple and free system for classifying habitat types that provides a robust survey approach for habitat research and Biodiversity Net Gain assessments.
- **Understorey** – The underlying vegetation layer below the canopy of a forest, usually occupied by shrubs or small/young trees.
- **Unoccupied grassland** – Grassland that is free of any human populations or use in agriculture.
- **Verge** – The strip of land alongside a road or path, which can provide physical links between habitats and represent corridors from animal movement.
- **Veteranisation** – Intentionally causing damage to young trees that would occur over many years naturally, such as stripped bark and hollowing.
- **Veteran tree** – Living trees of any age that exhibit some features of ancient trees, such as decay, fungal growth and dead wood. They provide holes and crevices important for wildlife.
- **Vulnerability of ecosystem**s – How susceptible an ecosystem is to stress.
- **Wetland scrape** – Shallow dips with gentle sloped edges that seasonally hold water and attract a lot of wildlife, particularly invertebrates and wading birds.
- **Wildflowers** – Uncultivated varieties of flowers that grow freely in the wild without any human action.
- **Woodland** – An area of land covered by trees, including plantation forest, natural forest and small tree stands.

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