Solar Energy UK

Solar Habitat 2025:

Ecological trends on solar farms in the UK

Solar Energy UK

is an established trade association working for and representing the entire solar and energy storage value chain. Solar Energy UK represents a thriving member-led community of more than 430 businesses and associates, including installers, manufacturers, distributors, large-scale developers, investors and law firms. Our underlying ethos has remained the same since our foundation in 1978 – to be a powerful voice for our members by catalysing their collective strengths to build a clean energy system for everyone's benefit. Our mission is to empower the UK's solar transformation.

Clarkson & Woods

provide a full range of ecological survey and consultancy services in respect to planning and land management. We are a leading consultancy in the survey, assessment and design of proposed and existing photovoltaic solar developments of all scales, from community owned to nationally significant projects.

We provide a range of services including survey and ecological assessment of solar and battery projects, development of bespoke management plans for solar farms and ecological monitoring of operational solar farms. We have a particular interest in furthering our understanding of the interactions between solar farms and ecology and have co-developed guidance in this area as well as embarking on pioneering research and collaboration with academic institutions.

Lancaster University

is a northern powerhouse of research excellence nested within a context of social and environmental sustainability. In the 2021 Research Excellence Framework, 91% of our research was independently rated as 'internationally excellent' or 'world leading'. We are ranked 7th in the UK for social and environmental sustainability.

The Energy Environment Interactions team focus on improving understanding of the implications of the energy transition on the environment, and how land use change for energy can be done in a way that delivers ecological, as well as climate, benefits. They sit within Lancaster Environment Centre, a 400-strong community of high-achieving students, world-class environmental researchers, government scientists and enterprises working together to address today's biggest environmental challenges, cutting across the physical and social sciences.

Wychwood Biodiversity

works with solar asset owners and managers to improve biodiversity on their land. Our team of ecologists is passionate about biodiversity and our core strengths lie in the planning, creation and management of bespoke wildlife habitats.

We've developed a range of services to support organisations at all stages of the project cycle, from pre-planning through to the long-term management of solar farms. We provide technical services to support planning applications, development of site management plans and ecological monitoring. We offer tried and tested means to achieve biodiversity gains for single sites or entire portfolios. We've worked with our project partners to produce guidance on biodiversity management for the entire solar industry.

Bumblebee, Wychwood Biodiversity

Contents

Front cover photo: White-tailed bumblebee, H. Blaydes, Lancaster University

Yellowhammer, Wychwood Biodiversity

Summary and highlighted findings

The 2025 Solar Habitat report reinforces our understanding of the positive impact of well-managed solar farms on biodiversity. The findings support best practices for ecological monitoring and land management, emphasizing that solar farms can function as valuable habitats while contributing to renewable energy goals.

The data from ecological monitoring on 124 sites conducted throughout 2024 was received for this year's report, representing around 11% of sites across the UK. This is another jump in the number of sites, from 87 last year, and brings the total number of sites surveyed in Solar Habitat reports between 2023 and 2025 to 248. The sites included within this report were found to be generally representative of solar farms across the UK in terms of age, output and geography.

The data is collected according to the Standardised Approach to Monitoring Biodiversity on Solar Farms[1]. A methodology made up of nine key components to be included in each survey and a list of nine optional components. Most surveys conducted included the key elements plus additional surveys for invertebrates, birds, soils and hedgerows (Figure 1.).

Following guidance in the Standardised Approach, sites are arranged into overall management categories based on their focus on biodiversity. Some sites have been further categorised by management for grassland, site margins and hedgerows. Analysis of overall management categories and survey data shows that sites managed for biodiversity support greater mean plant species richness, greater invertebrate species richness, and greater bird species richness. Key highlights have been outlined on the next page.

Grassland

- **More than 2,000 quadrats were used to assess grassland habitats across 124 solar farms.**
- **A total of 314 plant species were recorded across all quadrats, with an average of six species per quadrat.**
- **Greater numbers of plant species were recorded where efforts were made to enhance biodiversity.**

Hedgerows

- **Hedgerows were assessed at 29 solar farms, and a total of 44 different woody plant species were recorded.**
- **The majority of hedgerows were reported as in good condition.**
- **More plant species were recorded in hedgerows that were being managed with a biodiversity focus.**

Invertebrates

- **A total of 764 transects were walked across all solar farms.**
- **Almost 3,000 butterflies and bumblebees, comprising 29 different species, were observed across 64 solar farms on which transects were walked.**
- **Butterflies were around ten times more abundant than bumblebees, with one species of conservation interest recorded.**
- **Invertebrate biodiversity varied depending on transect location and solar farm management, with more individuals and species recorded in margin or enhanced areas and at sites with more biodiversity-focused management.**

Birds

- **Around 7,500 individual birds were counted as part of surveys undertaken at 63 solar farms, including a total of 94 different species.**
- **Of the species recorded, 28% were Amber Listed and 20% were Red Listed, with several exceptional species observed, including nightingale and cirl bunting.**
- **Bird biodiversity varied with solar farm management, with more individuals and species recorded at solar farms managed with a greater biodiversity focus.**

Mammals

- **Although targeted mammal surveys were not undertaken, incidental observations were made at 22 solar farms.**
- **Eight species of mammal were recorded, including water voles at one solar farm.**

Soils

- **Soil samples collected at 35 solar farms were analysed for a range of soil properties.**
- **Soil properties can provide insights into soil health and help to inform future solar farm management.**

Glossary

Amber Listed (birds) – bird species with an unfavourable conservation status in Europe, whose population/range has declined moderately in recent times or has a historically declining population but has made a recent substantial recovery, rare breeders and species for which the UK holds internationally important populations, as categorised by the British Trust for Ornithology1.[2]

Arisings – vegetation cuttings often left in situ after management.

Biodiversity Net Gain (BNG) – an approach to development that aims to deliver measurable improvements for biodiversity by creating or enhancing habitats.

Birds of Conservation Concern – British Trust for Ornithology Amber or Red Listed species[2].

BTO – British Trust for Ornithology.

Botany – relating to plants.

Broadleaf – a group of plants with relatively broad, flat leaves.

Climber - a group of plants that use twining stems, tendrils or sticky pads to cling to surfaces.

Ferns - a group of plants that reproduce using spores and do not have seeds or flowers.

Graminoid – grass, sedge or rush.

Green Listed (birds) – bird species that are of least conservation concern, whose population is stable or increasing, as categorised by the British Trust for Ornithology[2].

Incidental (observations) - biodiversity sightings outside of structured surveys.

Injurious weed – a plant that can damage crops, habitats or ecosystems, as prescribed in the Weeds Act 1959.

Least Concern (butterflies) – butterfly species that widespread and abundant, as categorised by Butterfly Conservation[3].

Quadrat – a square plot of land marked out for botanical assessment.

Red Listed (birds) – bird species that are globally threatened, whose population/range has declined rapidly in recent times or that have declined historically and not shown recovery, as categorised by the British Trust for Ornithology[2].

Strings (of panels) – a row of panels that are wired together.

Sward – a grassland area.

Transect – a walked line through a habitat used to make measurements or observations.

UK Habitat Classification System (UKHab) – a system for classifying vegetation in the UK, required for Biodiversity Net Gain.

Vulnerable (butterflies) – butterfly species that are considered to be facing a risk of extinction in the wild, as categorised by Butterfly Conservation.

Woody plants – a group of plants whose stems/roots are reinforced with wood (typically trees and shrubs).

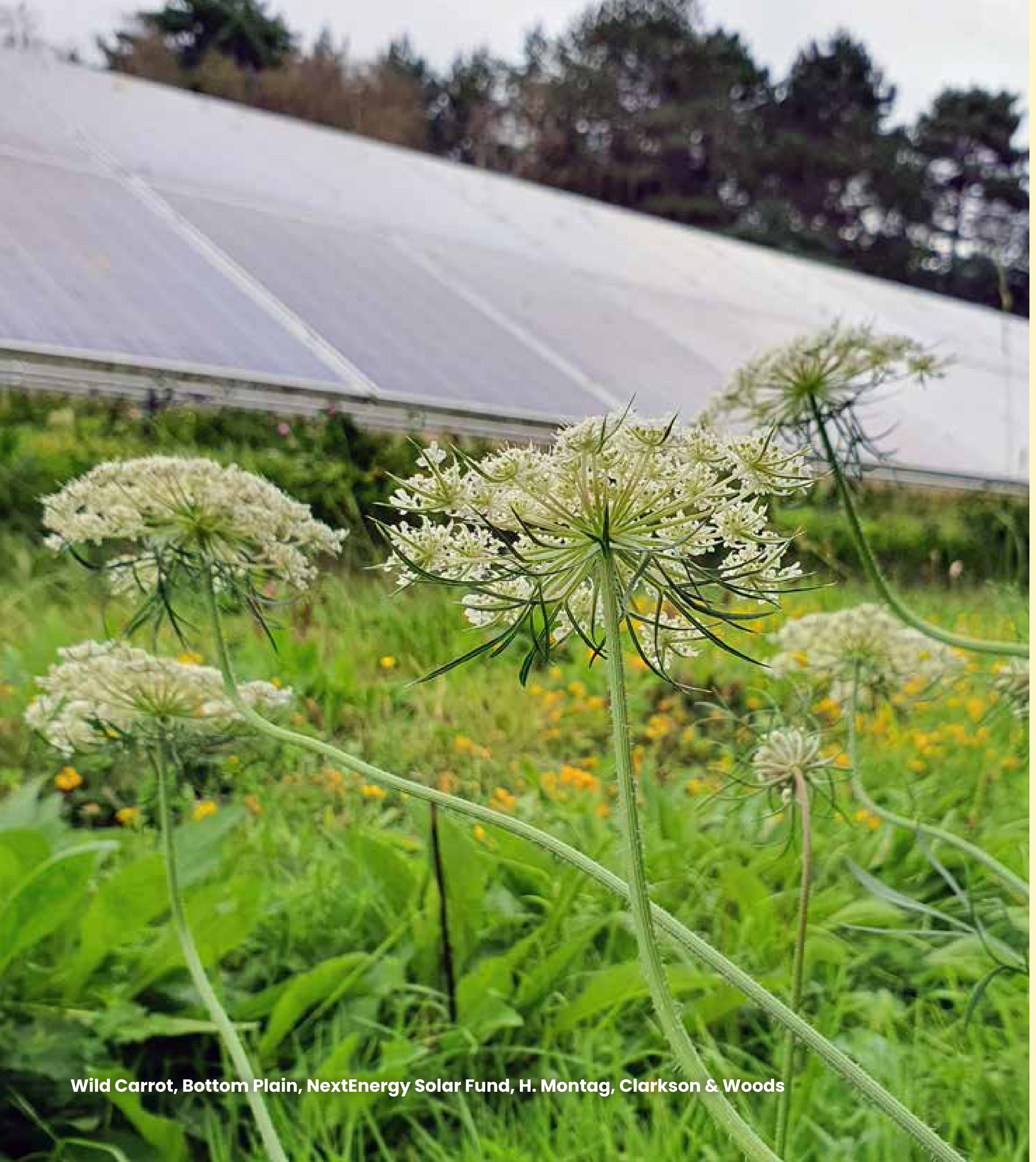
Introduction

Solar Energy UK, in collaboration with Clarkson & Woods, Wychwood Biodiversity and Lancaster University are pleased to present the third Solar Habitat report, highlighting ecological trends on solar farms in the UK. This report follows on from the pilot Solar Habitat published in 2023 and the second report published in 2024. The Solar Habitat reports are based on data collected from solar farms using the Standardised Approach to Monitoring Biodiversity on Solar Farms[1] methodology. The scope of data collection has expanded significantly over the years, increasing from 37 solar farms monitored in 2022 to 87 in 2023, and reaching 124 sites in this 2024 report.

Solar Habitat reports focus on botany, invertebrates, birds, soil and mammals found on solar farms, alongside case studies giving the context of ecological monitoring on solar farms, highlighting innovative ecological practices and exploring research being undertaken on the impact solar farms have on biodiversity.

The case studies in Solar Habitat 2025 aim to give the reader a perspective on the practice and potential costs of ecological monitoring. Three case studies look at managing and monitoring a solar farm to promote greater biodiversity. Three further case studies discuss research and innovation, including a study of birds on solar farms, promoting soil carbon, and innovations in ecological monitoring technology.

Skipper butterfly, H. Blaydes, Lancaster University



Wild Carrot, Bottom Plain, NextEnergy Solar Fund, H. Montag, Clarkson & Woods

Monitoring ecology

Monitoring ecology on solar farms

The motivation to conduct ecological monitoring on a solar farm can come from a planning requirement, or to check that new habitats are establishing well, or to better understand the impacts of solar farms on biodiversity. Further, some level of biodiversity monitoring will be required as sites receive planning permission under BNG.

Solar Habitat takes the data collected during the past monitoring season, whatever the motivation, and analyses data to identify trends, most notably the impact of management on botany, invertebrates and birds and how these relate to each other. This helps us to better understand how solar farms can support biodiversity and to guide the management of solar farms moving forwards.

Solar Habitat data

Solar Habitat is an annual report, providing a snapshot of ecology on solar farms in the year data was collected. Across three reports there have been a handful of sites which have been monitored each year, but the majority have been unique.

The trends identified suggest that well managed solar farms can support biodiversity and are in line with previous Solar Habitat reports. As the data set grows and an increasing number of sites are monitored regularly, long terms trends will hopefully become an additional feature of the report.

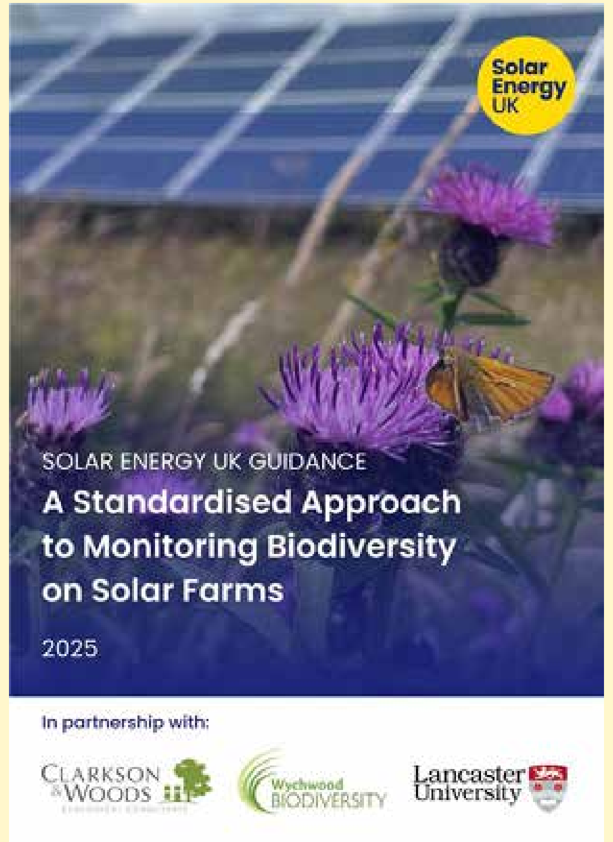
Update to the Standardised Approach

The Standardised Approach to Monitoring Biodiversity on Solar Farms[1] is designed to establish a common standard which enables the comparison of data from solar farms across the entire country.

The methodology was designed to be conducted over a one-day period by a generalist ecologist however, as sites have grown in size this has become more difficult. In the updated methodology an approximate time on site is given for each element, including the five core elements as well as the additional elements. This helps to estimate the required time on site for monitoring a solar farm and to give an indication if the monitoring might take more than a single day or visit. Additionally, methodologies for soil sample collection and management scores have been revised. To understand more the methodology please access the methodology on the Solar Energy UK website.

Third-party monitoring data

In the first two editions of Solar Habitat all data was provided by two ecological consultants, Clarkson & Woods and Wychwood Biodiversity, project partners in both developing the methodology and in authoring the Solar Habitat reports. In Solar Habitat 2025, for the first time some of the data has been provided by a third-party ecological consultant, Envance. They provided data for five sites using the Standardised Approach which have been included within the report. It is hoped that a growing number of consultants will submit data to support future reports.



View this report at solarenergyuk.org/resource

Or scan the QR code to access this guidance.


Botanical quadrat survey, Clarkson & Woods

Case Study

What is solar monitoring?

Ecological monitoring on solar farms may be a requirement under a management plan, but it is also a useful tool to ensure that any problems can be detected early such as the spread of unwanted weeds or failure of planting or seeding. In addition, companies may want to participate in the collection of data to broaden their understanding of how solar farms interact with nature.

Most ecological consultancies can offer this service and a Standardised Approach has been developed to ensure the same type of information is collected in the same way. The Standardised Approach has been designed on a sliding scale so that as a minimum, key components can be collected at low cost (often under £2,000 for smaller sites, increasing with site size and complexity). Additional elements can be added where there is interest or requirements given the characteristics of the site.

Habitat survey

This entails the mapping of habitats using the UK Habitat classification system, as well as collection of botanical quadrat data. Quadrats are 1 m by 1 m squared which are laid out in specific areas so that all plants within it can be measured (species and percentage cover). The quadrats are surveyed between the panel rows, underneath the panels, at the edge of the site and in any areas of enhanced biodiversity (if applicable), so that differences in botanical composition and diversity can be identified. Such differences can provide insight into our current understanding of what kind of habitats can feasibly be created and maintained across the different areas of a solar farm.

Soil sampling

Collecting soil samples for analysis can be helpful to track nutrient levels, guide management and inform seed mixes to be used on a site. Soil sampling is done by collecting shallow cores of soil, mixing them together and sending a subsample to a laboratory.

Fixed point photographs

Photographs are taken at the same position each visit providing a useful visual guide to track site changes over the years.

Incidental sightings

Ecologists employ a investigative approach, examining signs for animal sighting such as hairs, footprints, pellets, and scat. Any interesting plants and animals are recorded during the survey to build up a picture of the range of wildlife that are using the site.

Further surveys

On top of the core surveys described above, specific data can be collected on various other aspects of biodiversity, including butterflies, bumblebees, birds, bats, reptiles, as well as environmental data. An ecologist can help determine which further surveys would be suitable on a specific site depending on the habitats and species present in the local area.


Elephant hawk moth caterpillar, Bottom Plain, NextEnergy Solar Fund, M. Montag, Clarkson & Woods

Overview of solar farms

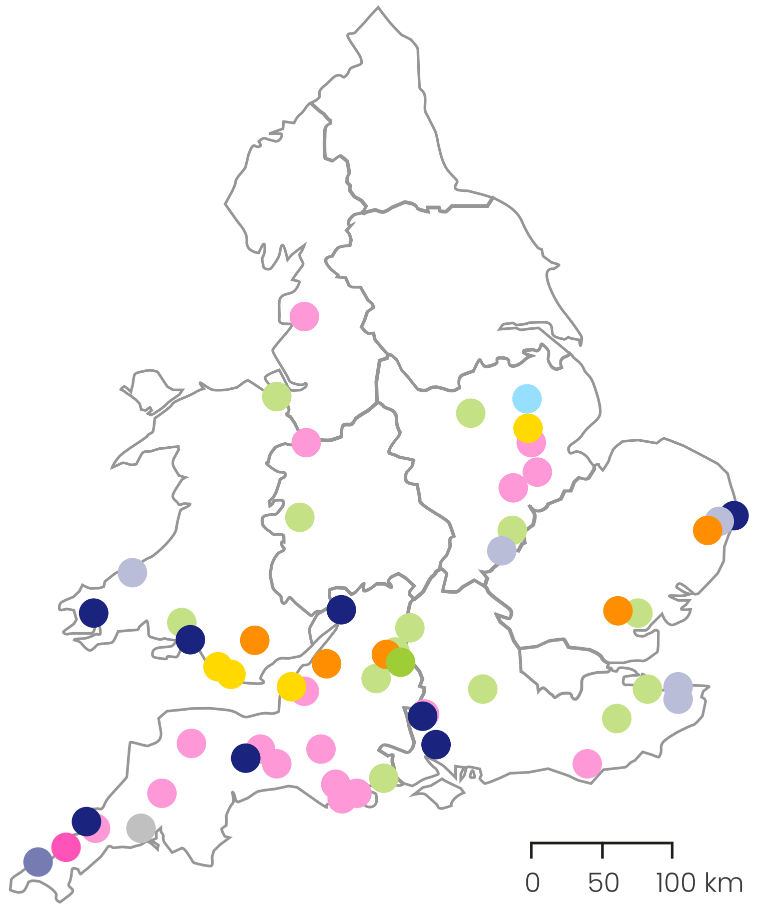
In 2024, data collected from 124 solar farms were submitted for inclusion in the Solar Habitat report, which is around 11% of the total number of sites across the UK[4]. The majority of these solar farms were new to Solar Habitat (106 sites; 85%), with only 18 sites (15%) included in previous reports. A range of data were collected across the solar farms, focusing on botany, hedgerows, invertebrates, birds and soils (Figure 1).

Most solar farms in the Solar Habitat sample were located in England (89%; 110 sites), with the majority in the South West (42%), the South East (16%) and the East Midlands (12%), broadly mirroring the national distribution of sites. At the county level, Devon and Somerset contained the greatest number of solar farms that submitted data to Solar Habitat, with 11% and 8%, respectively. Around 11%, (14 sites) of solar farms were in Wales, which matches the distribution of all solar farms in the UK. Although past Solar Habitat reports have included sites data from solar farms in Scotland and Northern Ireland, no monitoring data were submitted to this report.

Solar farms included in this Solar Habitat report varied in terms of their age, area and capacity, but were broadly representative of solar farms across the country. The average age of solar farms in the Solar Habitat sample was nine years (ranging from two to twelve) which is the same as the national average (calculated using the Renewable Energy Planning Database[4]). The average area of sites included in the sample was 16 hectares (ranging from one to 79 hectares), which is slightly larger than the national average of 14 hectares. In terms of the capacity, solar farms in the Solar Habitat sample had an average capacity of 9 MW (ranging from 1 to 46 MW), which is similar to the national average of 8 MW.

Most solar farms monitored in 2024 were assessed in terms of how habitats on site were managed and were assigned an overall management category based on the focus on biodiversity (91%; 113 sites; Table 1). More than half of all solar farms were assigned to Category 3 (58 sites, 51%), indicating some consideration of biodiversity. Some solar farms were assigned to Category 2 (30%; 34 sites), suggesting management with a greater focus on biodiversity and the remaining sites were placed into Category 4 (19%; 21 sites), indicating less consideration.

The reason that no solar farms reached the criteria for Category 1 is most likely attributed to the challenges of cutting and collecting grass arisings; specialist machinery is often needed and this is explored in the case study: cutting and collecting arisings at solar farms, on page 16. Removing arisings repeatedly ensures that biomass and the nutrients that they contain are also removed from the grassland, and over time, this typically encourages a more diverse plant community[5,6].



	Botany	Hedgerow	Invertebrates	Birds	Soil	Count
	X		X	X		42
	X					21
	X	X			X	16
	X	X				12
	X		X	X	X	11
	X			X		7
	X		X		X	6
	X		X			5
	X	X		X		1
	X	X	X	X		1
	X				X	1
	X			X	X	1

Figure 1: Locations of solar farms that submitted monitoring data to Solar Habitat in 2024. Dots are coloured according to the surveys undertaken at that site. The table shows the combinations of surveys carried out at solar farms, ordered by count (i.e. the number of solar farms where this combination took place).

Table 1: Site management categories. Categories defined as in the Standardised Approach to Monitoring Biodiversity on Solar Farms.

1	**Optimal management for biodiversity with conservation cutting/ grazing and no herbicide use. Arisings are removed from the site. A range of habitats (e.g. meadows, tussocky grassland, woodland planting, hedgerow planting) are present.**
2	**Conservation cutting or grazing takes place on site. Arisings are left on the site with signs of thatch of vegetation in places. A range of habitats are present. Herbicides may be used, but spot treatment only.**
3	**Site is cut or grazed throughout the year leading to a short sward in the summer months. Some other habitats are present, such as tussocky margins or planted hedgerows/woodland. Use of herbicides are apparent (e.g. blanket spraying beneath the solar panels).**
4	**Site is cut or grazed throughout the year leading to a short sward in the summer months. No other habitats (e.g. tussocky margins, new hedgerows or woodland) are present. Use of herbicides is apparent (e.g. blanket spraying of fields or beneath the solar panels).**
5	**Site is unmanaged or "other".**

As a trial of a new management categorisation system to add depth to the analysis of on site management, additional site management information was collected on some solar farms. It was possible therefore to categorise sites based on how different habitats within the site were managed (Table 2). Categories focused on the (1) grassland around the solar array (information was available for 45 sites), (2) grasslands or field margins outside of the array (but within the lease area; information was available for 42 sites) and (3) hedgerows (information was available for 32 sites).

The majority of grassland directly around the solar arrays were assigned to Categories 3 (40%; 18 sites), or 4 (51%; 23 sites), with two sites placed into Category 2 (4%) and two sites placed into Category 1 (4%; Figure 2). However, most grassland outside of arrays/ field margins were less intensively managed and assigned to Category 2 (55%; 23 sites), with some placed into Category 1 (19%; eight sites), with a smaller proportion assigned to Category 3 (26%; eleven sites) and none placed into Category 4 (Figure 2). This is likely because grasslands and field margins away from solar panels do not need to be kept short to avoid panel shading.

Table 2: Site management categories, split by solar farm habitat type. Information for individual habitats were only available for a subset of the solar farms that submitted data to Solar Habitat in 2024.

Grassland around the solar array	1	**Grassland managed through hay cut (after late July) and arisings are collected.**
	2	**Grassland is conservation cut or grazed (e.g. sheep are removed for at least two months over the summer). Arisings may not be collected.**
	3	**Grassland is managed at a low intensity resulting in variable sward height.**
	4	**Grassland is cut or grazed intensively resulting in a short and uniform sward.**
	5	**Grassland is unmanaged or "other".**
Grasslands or field margins outside of the array (but within the lease area)	1	**Grasslands or field margins are managed for biodiversity (e.g. conservation management, seeded or other specific interventions).**
	2	**Grasslands or field margins are managed at relatively low intensity, resulting in variable sward height.**
	3	**Grasslands or field margins are cut or grazed intensively, resulting in a short and uniform sward.**
	4	**Grassland or field margins are unmanaged or "other".**
Hedgerows	1	**Most hedgerows within the site are managed for biodiversity (e.g. bushy, cut every two years or less, at least 2 m tall, good margins etc.)**
	2	**The management or condition of hedgerows across the site varies.**
	3	**Most hedgerows within the site are not managed for biodiversity.**
	4	**Hedgerows are unmanaged or "other".**

At many solar farms, hedgerows appeared to be managed with some consideration for biodiversity (66%; 21 sites). Management for biodiversity can involve allowing hedgerows to increase in height and width through less intensive cutting regimes (e.g. trimming every couple of years, rather than annually), among other practices[7]. Hedgerow management seemed to vary at some sites (28%; nine sites) and there appeared to be no management for biodiversity at two sites (6%; Figure 2). As there is no national database containing details of how solar farms are managed, it is not possible to tell if sites included in the Solar Habitat sample are representative of site management across the UK.

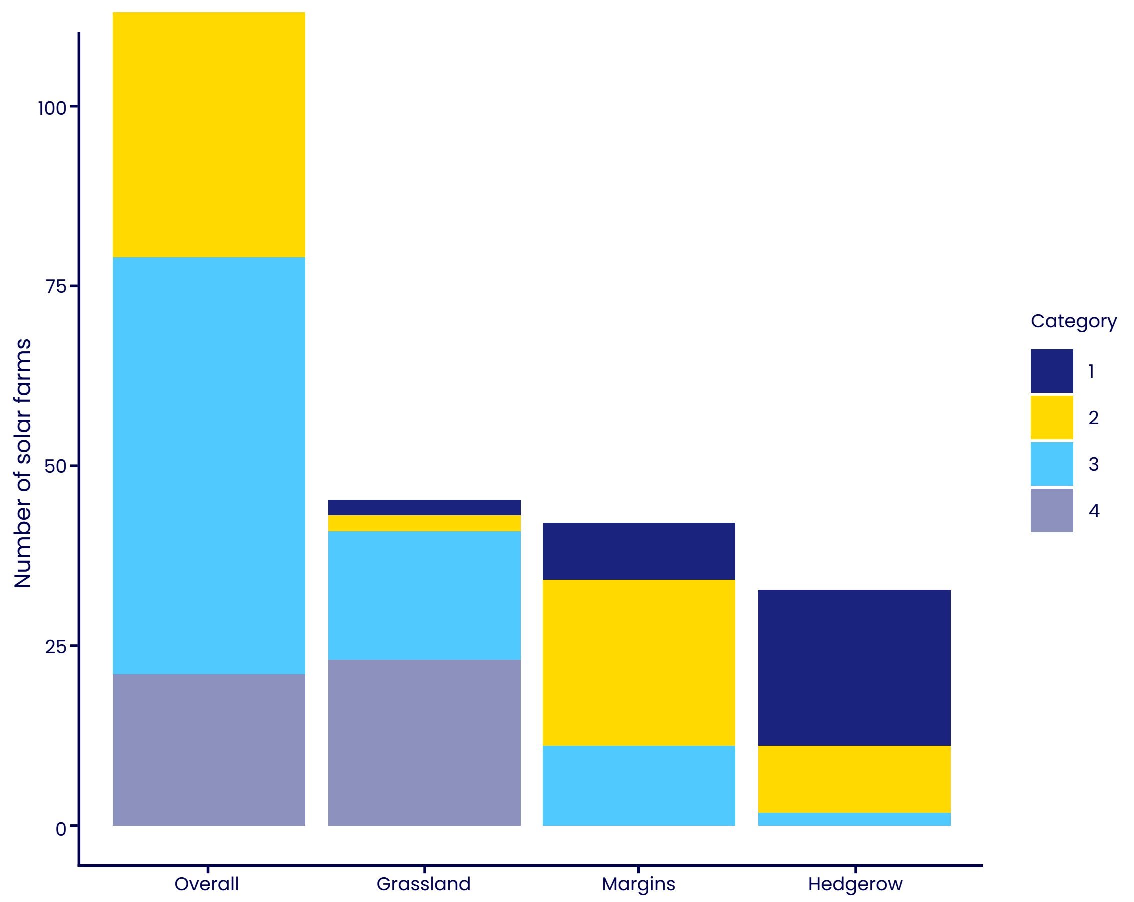


Figure 2: The number of solar farms placed into each management category. Categories are split into those for solar farms overall ("overall"), based on the Standardised Approach, and three habitat types, outlines in Table 2; grasslands around the arrays ("grassland"), grasslands or field margins outside of the array ("margin"; but within the lease area) and hedgerows ("hedgerow").

Wild flower meadow, H Blaydes, Lancaster University

CASE STUDY: Southill solar farm

Southill solar farm is a 5 MW site constructed in West Oxfordshire in 2016. It is owned by Southill Community Energy and the land is managed by Wychwood Biodiversity. The site's Biodiversity Management Plan specifies cut and collect within the solar farm security fence line to encourage wildflowers into the fine grass sward. The whole site (including around the solar panels) was cut and collected in 2023 and 2024 using an Iseki 237 box mower. The cuttings were loaded into a box trailer using the high-lift box of the Iseki and exported offsite for cattle bedding.

Time taken:
two full days

Cost of mower and operator:
£2,208

Cost of trailer and disposal:
£600

Additional labour, site access etc:
£400

Total cost:
£3,208 for seven hectares

Cost per land area: approximately £460 per hectare / £185 per acre

Case Study

Cutting and collecting arisings at solar farms

'Cut and collect' is a somewhat contentious approach to grassland management on solar farms, with many ecologists favouring the approach and many Operation and Maintenance teams finding it difficult or impossible to fulfil. This case study explores the costs and benefits of cut and collect using insight from a solar farm in Oxfordshire which has been implementing this technique around the solar arrays for the past two years.

Why are ecologists so keen on cut and collect?

The simple answer is that most grass cutting does not result in positive conservation outcomes. Cutting the grass conventionally leaves a layer of cuttings which smother the existing grass and creates dead patches.


Wild flowers, Southill solar farm

Further, the cuttings break down and nutrify the soil. This encourages the faster growing agricultural grasses such as cock's foot (*Dactylis glomerata*), Yorkshire fog (*Holcus lanatus*) and rye grass (*Lolium perenne*), and discourages slower growing grasses such as fescues and bents (often referred to as 'fine grasses') and wildflowers.

Conversely, 'cut and collect' is an approach whereby the grass cuttings are removed after cutting, either immediately with a box collector, or after cutting with a baling machine. Removal ensures there is no layer of cuttings left behind to smother the grass and nutrify the soil, and this can result in lower nutrient conditions which favour fine grasses and wildflowers. Traditional hay meadows are managed this way and over many years they can become very botanically rich.

Considerations

1. Cut and collect is designed to encourage fine grasses and wildflowers and therefore should only be used where there is potential for these to develop on a site.
2. There must be a plan for the disposal of large quantities of cuttings. Piles of cuttings should not be left heaped on site as they may present a fire risk and can cause nutrient run-off into watercourses.
3. Cut and collect machines can be larger than conventional mowers owing to the collector box and so may be less suited to tighter row spacing and confined areas.
4. To have a positive effect upon grassland, cut and collect needs to be undertaken for a minimum of 2-3 years. In addition, for maximum benefit, the cutting must be done at the end of the main flowering season (i.e. avoiding April – July inclusive). Further, other management activities, (e.g. weed control), must be designed to support wildflowers.
5. Cut and collect requires specialist equipment which is more expensive to hire or purchase. Further additional time will be needed to manage the cuttings.

Alternatives to cut and collect

If cut and collect is not possible on a site several alternatives could be tried:

- Cut and mulch – using a machine that cuts and mulches the grass is better than conventional mowers as it cuts the grass cuttings into tiny pieces, reducing the thickness of the cut grass layer. However, the soil will still be nutrified as the cuttings break down.
- Cut and aftermath grazing – sheep are introduced to the site immediately following cutting. The sheep will eat some of the cuttings, and trample the rest, so a thick layer is avoided. Nutrient input to the soil is reduced as some cuttings are eaten and deposited as sheep dung.

Conclusions

Cut and collect is possible on solar farms. It is more expensive than conventional cutting, but the specialist equipment is becoming more readily available. The advantages of cut and collect is that it encourages wildflowers and fine grasses, which can be management priorities for some sites. It also reduces nutrients on site and over time this will reduce grass vigour, meaning less need to cut.

Given the costs are higher, cut and collect is most appropriate for sites where wildflowers are already present or where they are specified in the management plan. Where cut and collect is not viable, it may be valuable to explore mulching mowers or aftermath grazing as a less effective but lower cost alternative to cut and collect.


Iseki cut & collect mower


Pyramidal orchid, H. Blaydes, Lancaster University

Botany

Botanical surveys within solar farms focused mainly on grassland habitats, which represent the largest habitat within a site. Grasslands are important because they can be rich with many different species of wild plant, which can support other biodiversity groups. Grasslands also provide a range of ecosystem services important for humans and wildlife, including water regulation and soil preservation. However, grasslands are among the most threatened habitats in the UK, with much of their loss attributed to agricultural development[7]. The intensification of pasture, driven by the sowing of less diverse, highly competitive palatable grasses and heavy fertiliser use to maximise yield has replaced traditional meadow grazing methods. Traditional approaches to management, which involve lower fertiliser inputs and do not require periodic reseeding, support significantly higher biodiversity.

Due to their less intensive management, solar farms offer an excellent opportunity for grassland restoration, allowing diverse plant communities to thrive without the need for fertilisers or intensive regimes. Additionally, they can still accommodate grazing animals, which when introduced in lower numbers or managed through conservation grazing, contribute to maintaining and enhancing species-rich grasslands.

Botanical quadrats

Botanical quadrats were used to assess grassland habitats within all solar farms, with a total of 2,146 surveyed across the 124 sites. Most quadrats were 1 m x 1 m in size (1,296 quadrats), others were 2 m x 2 m in size (790 quadrats) and the size of 60 quadrats was unknown. Quadrat size differed across ecological consultancies that carried out the surveys, but previous statistical analyses showed minimal impacts on results, making it possible to compare data across quadrat sizes.

Quadrats were used within different areas of the solar farm, including directly beneath solar panels ("under"; a total of 697 quadrats), between the rows of solar panels ("between"; a total of 707), in areas outside of the main footprint of the solar panels such as field margins which may be inside or outside of the security fencing ("outside"; a total of 553 quadrats) and in areas managed or enhanced specifically for biodiversity ("enhanced"; a total of 189 quadrats).

At many sites, five quadrats were assessed under the solar panels, five were assessed between the rows of panels and five were assessed in field margins or other habitats. Enhanced areas were surveyed where they were present. On average, 15 quadrats were assessed at each solar farm, but there was much variation, with the number of quadrats per site ranging from four to 65. More quadrats tended to be surveyed at larger solar farms and those with more variation in habitat types.

Solar farms have generally increased in size over time[8] and this trend is set to continue, especially given the number of Nationally Significant Infrastructure Project solar farms recently approved. As solar farm area increases, it becomes more costly to collect data that are representative of the site, risking not capturing biodiversity across the site. Some areas of a site may be homogenous and only need a few quadrats to characterise them, whereas others may be more diverse and need a higher density of quadrats. The key thing is to ensure the site's diversity has been captured.

Botanical species richness

Within each quadrat, the number of plant species and the percentage of the quadrat they occupied were recorded. Across all solar farms, a total of 314 plant species were observed. Most of these species were broadleaf plants (221 species), but many graminoids were also recorded (72 species), along with a variety of other species including woody plants, climbers, ferns and agricultural plants (21 species).

The most frequently recorded plant type was graminoids, with Yorkshire fog (*Holcus lanatus*) present in 71.8% of all quadrats, followed by common bent (*Agrostis capillaris*) found in 43.2% and rough meadow grass (*Poa trivialis*) recorded in 29.8% of quadrats. The most frequently recorded broadleaf species was creeping buttercup (*Ranunculus repens*) found in 20.0% of quadrats, followed by creeping thistle (*Cirsium arvense*) found in 14.8% of quadrats and white clover (*Trifolium repens*) recorded in 13.3%. Both creeping buttercup and white clover are species indicative of nutrient enrichment in the soil.

A number of interesting plant species were recorded inside quadrats, including four species of orchid. Bee orchid (*Ophrys apifera*) was recorded in one quadrat, common spotted orchid (*Dactylorhiza fuchsii*) in one quadrat, pyramidal orchid (*Anacamptis pyramidalis*) in five quadrats (across three different solar farms) and southern marsh orchid (*Dactylorhiza praetermissa*) in one quadrat. Orchids can be good indicators of healthy grassland ecosystems.

The average number of plant species recorded inside a quadrat was six, but this was variable and ranged from one to 21. There were differences in the number of plant species recorded inside quadrats depending on their location within the solar farm. On average, quadrats assessed in enhanced areas contained the highest number of plant species, followed by those in outside areas, margins, between the rows of panels and under the solar panels (Figure 3).

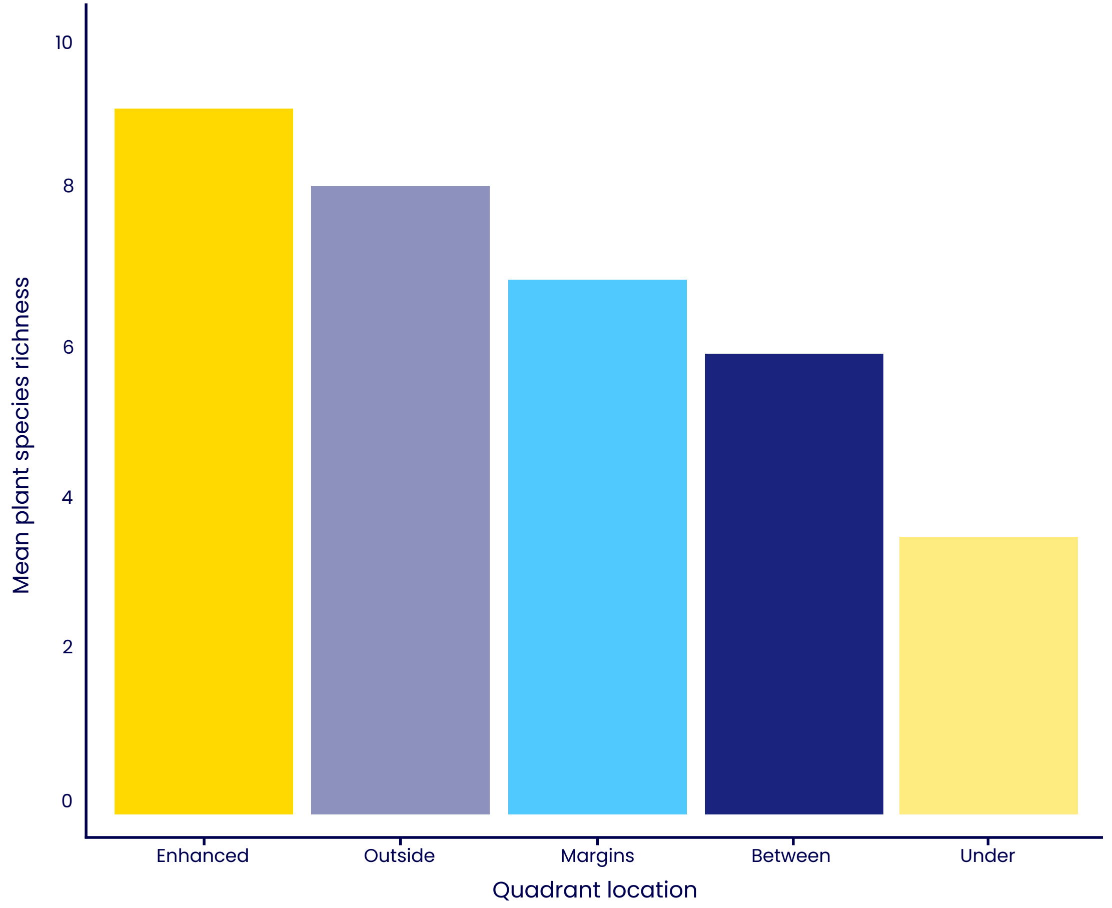


Figure 3. Average plant species richness by quadrat location. The mean number of plant species recorded inside quadrats surveyed in different locations within solar farms.

Plant species richness also varied at the site level, ranging from four to 66 species recorded, incorporating quadrats surveyed in all areas of the sites. The number of plant species observed varied with how the solar farm was managed, with an average of 31 species recorded at solar farms placed into overall management Category 2, 28 species at solar farms placed into Category 3 and 23 species at those considered to be in Category 4 (Figure 4).

Incidental observations

Alongside botanical quadrats, plant species were recorded as part of incidental observations at some solar farms, where ecologists recorded plants they identified whilst moving around the site or conducting other surveys. A total of 154 observations were made across 21 sites. Most observations focused on broadleaf species (77%), as they are typically more noticeable, but some observations of graminoids (18%) and other species (5%) were also made. A total of 102 plant species were identified, 23 of which were not recorded in quadrats as part of structured surveys.

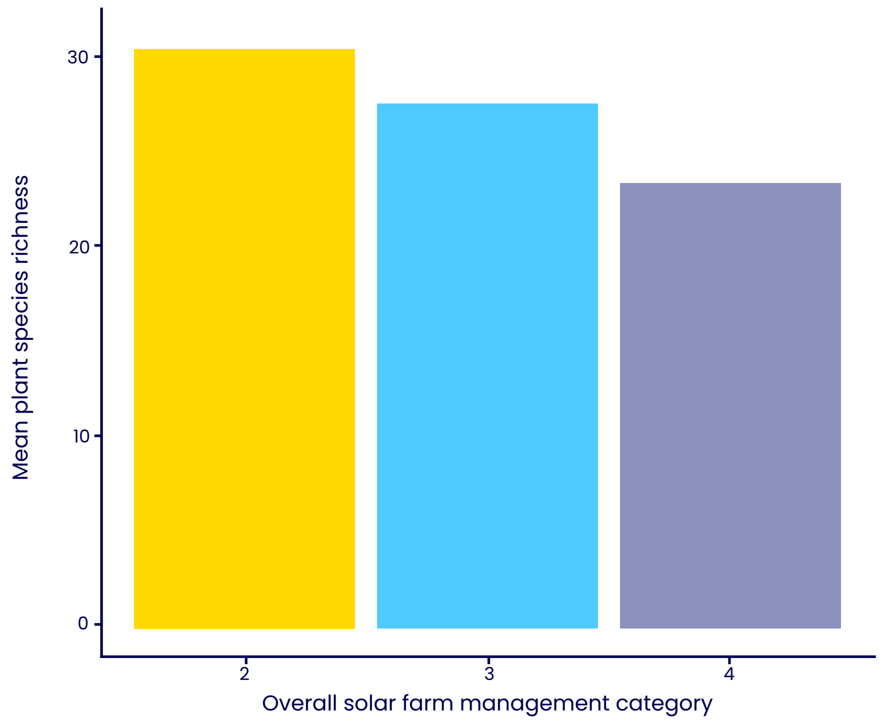
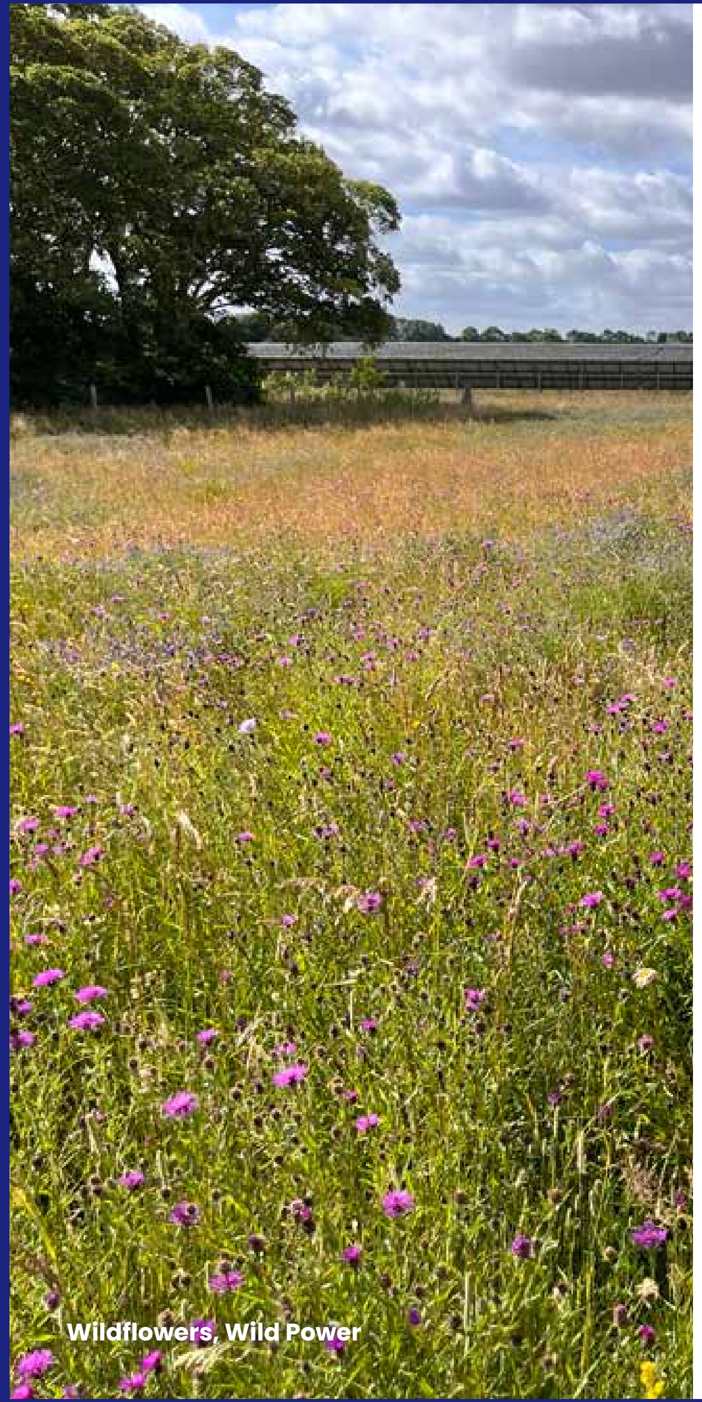


Figure 4. Average plant species richness by solar farm overall management category. The mean number of plant species recorded at the solar farm scale by solar farm management category.

Oxeye daisy, H. Blaydes, Lancaster University



Case Study

Wild Power Certification for West Raynham Solar Farm

A way to measure, validate and verify biodiversity

The Wild Power Solar Biodiversity Scorecard integrates habitat creation, extent and condition, connectivity, biodiversity, ecosystem services and management actions to provide a holistic view of a site's contribution to biodiversity and is the basis for the Wild Power Certification scheme[9]. Over 50 UK solar farms have been surveyed using the Scorecard during Wild Power's calibration phase and the first Wild Power certification was issued to Bluefield Solar Income Fund's West Raynham Solar Farm in May 2024.

◀ Wildflowers at West Raynham Solar Farm now cover an area of approximately 40 acres, providing habitat and foraging for pollinators and birds. This area is managed following a conservation sheep grazing regime.

CASE STUDY: West Raynham Solar Farm

West Raynham Solar Farm occupies approximately 91 hectares of a disused airbase. The land had previously been dominated by extensive areas of open, sheep grazed, semi-improved grassland, former runways and two parcels of arable land. As such the site presented considerable opportunity for biodiversity enhancement, which has been realised under Bluefield's stewardship.

Selected site features:

- Microhabitats have been installed throughout the site, with bird boxes (including barn owl boxes), bat boxes and log piles.
- Hedgerows, planted at construction, augment existing perimeter features to provide habitat, connectivity and foraging for local fauna.
- Invasive and injurious weeds have been identified and management plans enacted.
- Comprehensive biodiversity monitoring plans are in place for the site, including a number of biodiversity indicators (transects, breeding bird surveys, quadrats) and a fixed photo point monitoring programme. These have shown increasing wildflower diversity over time, Schedule 1 bird species, and farmland bird species of interest such as skylarks (*Alauda arvensis*).

Wild Power Certification

The measures highlighted above alongside a commitment to planning, creation and delivery of a thorough Biodiversity Management Plan contributed to West Raynham Solar Farm achieving Wild Power Gold status, Wild Power's highest level of certification. West Raynham Solar Farm is stated to be operational until 2055. Over this time, as a result of the efforts that Bluefield has put into enhancing biodiversity at the site, West Raynham Solar Farm will provide habitat and be a haven for nature concurrent with the benefits associated with renewable energy production.

wild power — WILD POWER CERTIFIED — NATURE FRIENDLY ENERGY

A five-acre tree planting area at the north of the site offers screening along with associated ecosystem services benefits such as additional habitat types, food sources, structural variation, soil and water control, carbon capture, and air purification. ▶

Hedgerows

In addition to grasslands, hedgerows are another important habitat for biodiversity at solar farms. Hedgerows can provide food and shelter for a range of biodiversity groups including invertebrates, birds and mammals. Hedgerows can also facilitate species movement across landscapes, acting as wildlife corridors, which are especially important for those that struggle to cross large, open areas, such as agricultural fields[10].

Hedgerow surveys

In 2024, hedgerows were assessed at 29 solar farms where ecologists recorded their condition (using Biodiversity Net Gain condition criteria), characteristics and species present. A total of 172 individual hedgerows were surveyed, with an average of four hedgerows assessed at each site (ranging from one to 19). Most hedgerows were noted as being in good condition (66%), with many in moderate condition (23%), a small number in poor condition (3%) and the condition of some hedgerows were not recorded (8%). Hedgerow condition scores are determined using the Biodiversity Net Gain methodology, assessing key traits including height, width, ground disturbance, damage, nutrient input and the presence of invasive species.

In total, 44 plant species were observed within hedgerows and the most commonly recorded was hawthorn (*Crataegus monogyna*; recorded in 83% of hedgerows), followed by blackthorn (*Prunus spinosa*; recorded in 78%) and field maple (*Acer campestre*; recorded in 34%). It is not surprising that these species were frequently recorded as blackthorn and hawthorn generally form the highest percentage of hedgerow whip mixes as they provide structure. Hedgerow habitats offer shelter and additional foraging habitat to the grassland on a solar farm and demonstrates how the inclusion of this important habitat within sites can introduce a suite of different species (namely woody plants).

On average, five plant species were recorded per hedgerow, but this ranged from one to eleven species. The number of species recorded varied with how the hedgerows were managed (Figure 5). Hedgerows at solar farms that were assigned to Category 1 (in terms of hedgerow management, as shown in Table 2) contained an average of six species, compared to five species at sites assigned to Category 2 and four species at sites in Category 3.

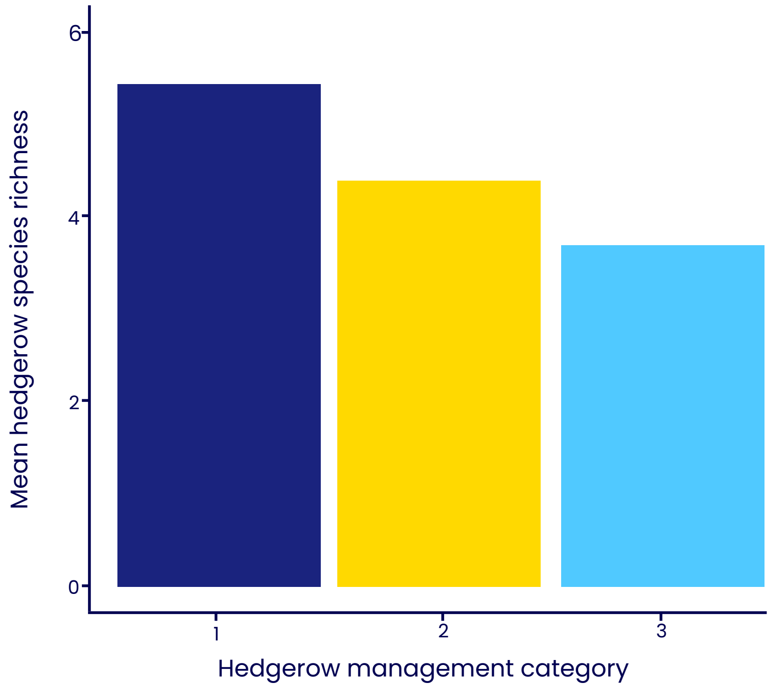


Figure 5. Average hedgerow species richness by hedgerow management Category 1. The mean number of species recorded in hedgerows at solar farms across hedgerow management categories.

Peacock butterfly, Wychwood Biodiversity

Invertebrates

Invertebrates provide a range of services beneficial to humans and wildlife, including the pollination of wild and agricultural plants. A key element of food chains, invertebrates are also a major source of food for biodiversity groups such as birds and bats. However, many invertebrate species have become less abundant and widespread over decades, with flying insects potentially declining by as much as 60% between 2004 and 2021 across the UK[11]. Preliminary data suggest that 2024 may have been the worst year on record for some groups such as butterflies, with low numbers attributed to poor weather conditions, set against the backdrop of other challenges that invertebrates face such as habitat loss, degradation, fragmentation and climate change[12].

Managing solar farms to provide suitable habitat for invertebrates could contribute to alleviating some of these challenges. For example, solar farms can be managed to provide critical food, nesting sites and microclimatic niches for invertebrates, as well as enhancing landscape connectivity[13] and appropriate management has shown to support greater invertebrate biodiversity within solar farms[14].

Transect walks

At 64 solar farms (52% of sites), butterflies and bumblebees were surveyed by ecologists walking transects. Transects focused on these invertebrate groups as they are identifiable in the field, unlike other groups which can require samples to be collected and examined under a microscope to identify species. Butterflies and bumblebees are also relatively large invertebrates, making them easier to spot when surveying, and they can act as indicators for the biodiversity of other invertebrate groups and environmental change[15].

Transects were generally 100 m in length and any butterfly or bumblebee within an imaginary 5 m x 5 m box around the surveyor was counted and identified to species level in most cases. A total of 764 transects were walked across all solar farms, either between the rows of solar panels ("between"; 396 transects) or in margins, open areas or areas enhanced for biodiversity ("outside"; 368 transects). On average, ten transects were walked at each solar farm, but this ranged from nine to 22.

Invertebrates continued

Butterflies and bumblebees recorded along transects

A total of 2,913 individual butterflies and bumblebees were counted along all transects, comprising 29 different species (23 butterfly and six bumblebee species). Butterflies were almost ten times more abundant than bumblebees, with 2,633 individual butterflies counted compared to 280 bumblebees. Butterflies may be more abundant as many of the species recorded are reliant on grasses, which are fed on by caterpillars and are therefore critical to complete their life cycle[16]. In contrast, bumblebees may instead be looking for flower rich areas, rather than areas of long grass, which may only be present where management is targeted to create such habitats at solar farms.

The most commonly recorded butterfly species was the meadow brown (*Maniola jurtina*), making up almost 60% of the total invertebrate count (1,717 individuals were recorded). Gatekeeper (*Pyronia tithonus*) and marbled white (*Melanargia galathea*) were also abundant, with 243 and 170 individuals counted, respectively. Almost all of the butterfly species recorded are classified as Least Concern, although one Vulnerable species was recorded: the small heath (*Coenonympha pamphilus*). Small heath were sighted at 15 solar farms, with 75 individuals observed across all of these sites. This species is classified as Vulnerable because although small heath is widespread throughout the UK, their distribution has declined significantly since the 1970s and due to their low dispersal ability, it is unlikely that populations of small heath from continental Europe could recolonise and help to expand the UK population[17].

In terms of bumblebees, the most frequently recorded species were the white-tailed bumblebee (*Bombus lucorum*; 127 individuals), the red-tailed bumblebee (*Bombus lapidarius*; 79 individuals) and the common carder bee (*Bombus pascuorum*; 34 individuals).

On average, one butterfly or bumblebee species was recorded along each transect (per 100 m), but this varied from zero to ten. In term of number of individuals counted per 100 m, the average was four but ranged from zero to 49. However, both the number of species and the number of individuals recorded along transects varied depending on where transects were walked. The number of individuals and species of butterflies and bumblebees collectively was greater in outside areas compared to between the rows of solar panels (Figure 6). On average, one species was observed along transects walked between the solar panels, compared to two walked in margins, open areas or areas enhanced for biodiversity (Figure 6). In terms of the number of individuals counted, an average of two individuals were sighted between the rows of solar panels, compared to six individuals in other areas (Figure 6).

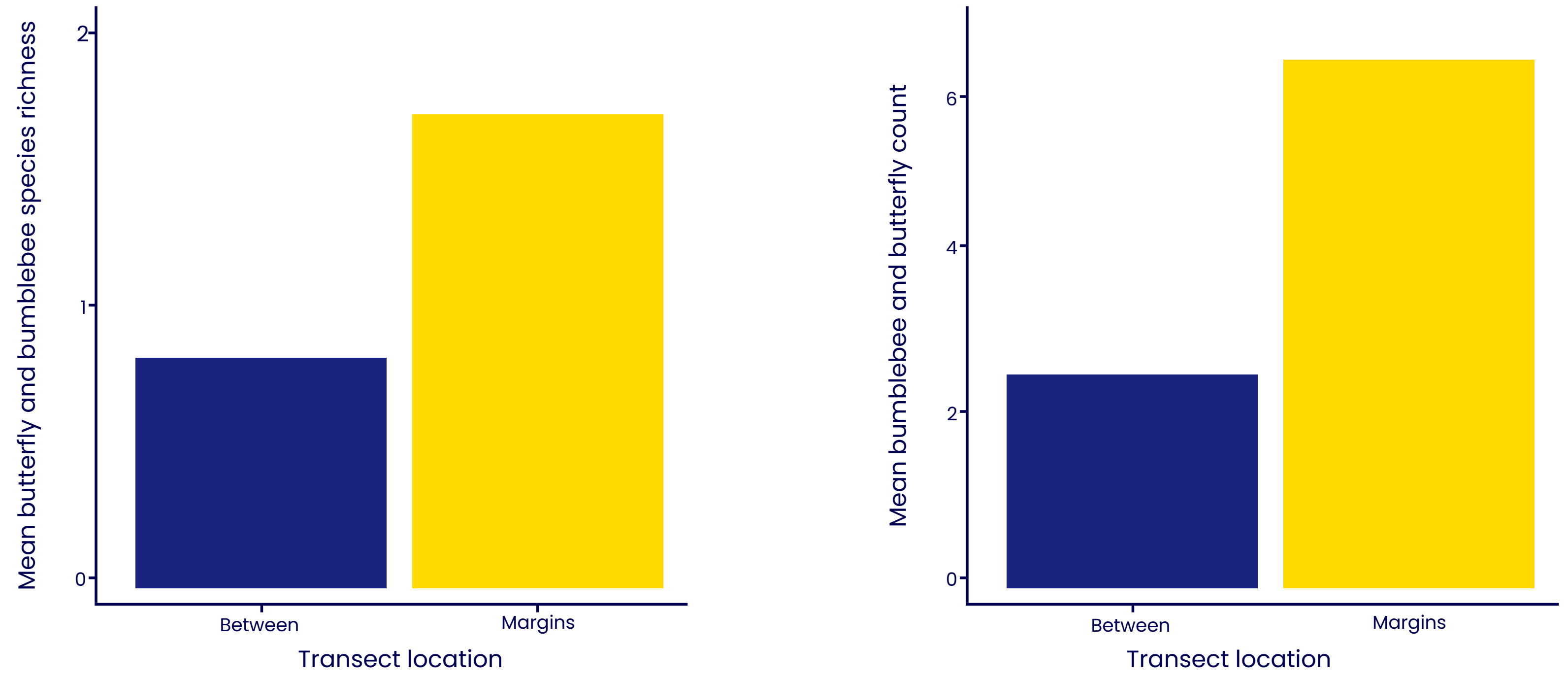


Figure 6. Butterfly and bumblebee biodiversity by transect location. The mean number of butterfly and bumblebee species (left) and count of individual butterflies and bumblebees (right) recorded along 100 m transects walked between the rows of solar panels ("between panels") and in margins, open areas or areas enhanced for biodiversity ("margins").

Invertebrates continued

Butterfly and bumblebee diversity also varied at the site level. The average number of species recorded was five, but this ranged from zero to twelve. The average number of individuals counted was 46, ranging from zero to 281. Solar farm butterfly and bumblebee species richness and counts varied according to how sites were managed, with the greatest numbers of species and individuals recorded at solar farms assigned to Category 2, followed by Category 3 and then Category 4 (Figure 7).

Whilst both transect location and site management appear to affect invertebrate biodiversity at solar farms, it is important to note that many other factors influence invertebrate biodiversity in this context. A positive relationship between plant and invertebrate species richness was observed (Figure 8), but other factors including landscape context, weather and climatic variables are likely to have an influence[18]. This is particularly true for the surveys undertaken in 2024, when the numbers across the country were extremely low due to weather conditions.

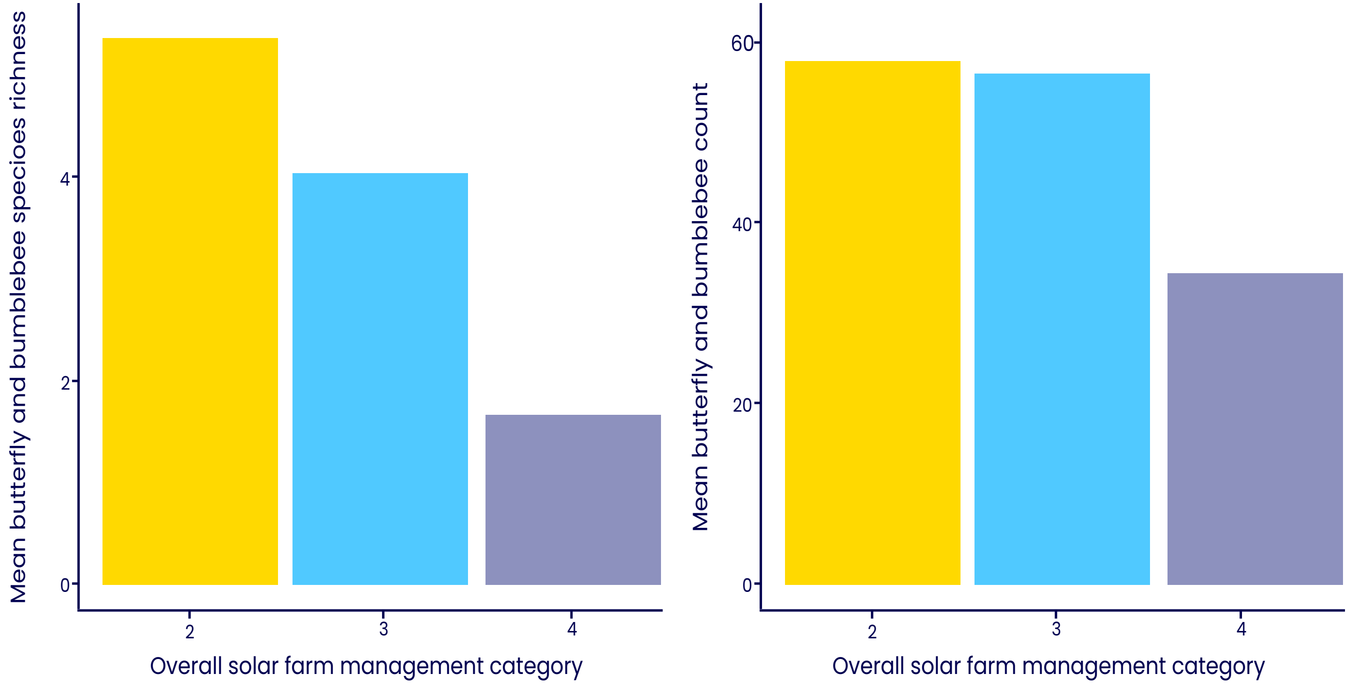


Figure 7. Butterfly and bumblebee biodiversity by solar farm overall management Category 2. The number of species (left) and individuals (right) of butterflies and bumblebees recorded at solar farms by overall management category.

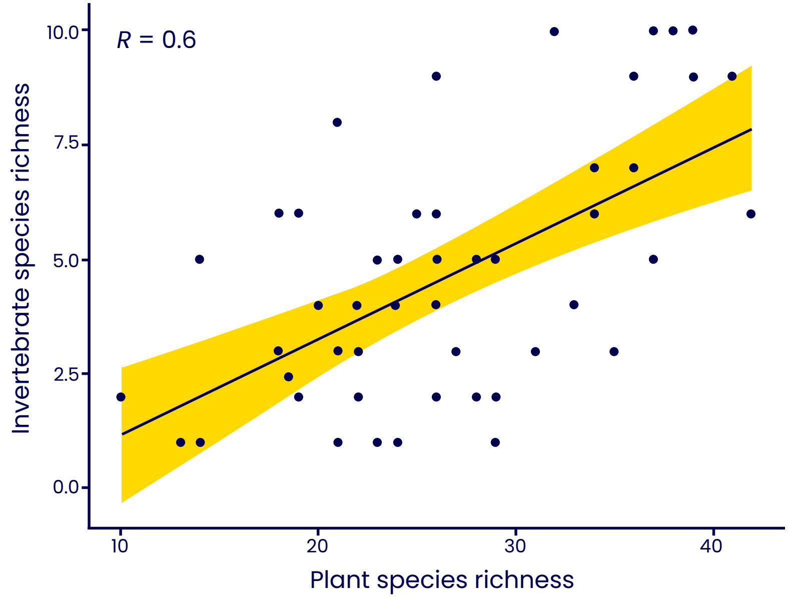


Figure 8. The relationship between plant and invertebrate (butterfly and bumblebee) species richness at the solar farm scale. The black line represents the trend line and the shaded areas represent 95% confidence intervals. The R value is the Pearson correlation coefficient.

Other invertebrates recorded along transects

Although transects were focused on butterflies and bumblebees, a total of 104 other invertebrates were recorded, comprising eight different species. Most individuals counted were honeybees (*Apis mellifera*; 68 individuals) and six-spot burnet moths (*Zygaena filipendulae*; 20 individuals). Other moth species recorded included five-spot burnet moths (*Zygaena lonicerae*; four individuals) and cinnabar moth (*Tyria jacobaeae*; one individual), along with odonates including common blue damselflies (*Enallagma cyathigerum*; five individuals), emperor dragonflies (*Anax imperator*; three individuals) and a broad bodied chaser (*Libellula depressa*; one individual). European hornets (*Vespa crabo*) were also recorded on two occasions.

Incidental observations

A total of 1,504 invertebrates were also observed at solar farms outside of structured transect walks. Such observations were made at 35 solar farms, including sites where structured surveys were not undertaken, and 42 species were recorded. These included 20 butterfly species, five bumblebee species, eight odonates and a range of other invertebrates including beetles, crickets, grasshoppers, hornets, moths and spiders.

Birds

Birds are a much-valued component of the UK's biodiversity, and their populations provide an indication of the broader state of wildlife as they occupy a wide range of habitats and respond to environmental pressures that affect other biodiversity groups. However, wild bird numbers across the UK are falling and since 2018 many bird species have suffered population declines19. The worst affected groups are farmland and woodland birds, which have declined by 61% and 35% since 1970[19]. However, there is emerging evidence that solar farms can support some bird species in agricultural landscapes by increasing structural diversity[20] and providing safe breeding areas[21].

Bird surveys

A total of 78 bird surveys were undertaken across 63 solar farms, with some sites being surveyed once (76% sites) and others twice (24% sites). Surveys involved a walked transect across each solar farm so that all habitats within 50 m of a transect were covered and all birds that were heard or seen were recorded.

Birds recorded as part of surveys

A total of 94 bird species were recorded as part of surveys and most were BTO Green Listed (49%; 46 species), although a significant proportion were Amber (28%; 26 species) or Red (20%; 19 species) Listed Species of Conservation Concern. There were also three species (3%) recorded which had no status, representing those which are not categorised by the BTO, as they are introduced species (e.g. little owl, *Athene noctua*) or game bird species (e.g. common pheasant, *Phasianus colchicus* and red legged partridge, *Alectoris rufa*).

In terms of bird count, a total of 7,459 individual birds were recorded. The most abundant Green Listed species was blue tit (*Cyanistes caeruleus*; 485 individuals), closely followed by goldfinch (*Carduelis carduelis*; 447 individuals).

The most abundant Amber Listed species was wood pigeon (*Columba palumbus*; 645 individuals), followed by wren (*Troglodytes troglodytes*; 589 individuals). It is unsurprising that these species were abundant and frequently recorded at solar farms given both woodpigeon and wren are generalist species that thrive in a variety of habitats. Although wren is on the Amber List, they are the most abundant species in the UK and were recorded during almost all bird surveys undertaken at solar farms (Figure 9). It is likely that they are attracted to the hedgerows and tussock grassland associated with solar farm boundaries.

The most abundant Red Listed species (in terms of the number of individuals counted) was starling (*Sturnus vulgaris*; 333 individuals), followed by linnet (*Linaria cannabina*; 223 individuals). When considering how frequently species were recorded (in terms of in how many surveys they were observed), starling were seen within around a third of all bird surveys (32%; Figure 9) and linnet were recorded within around half (49%; Figure 9). However, the most frequently observed Red Listed species was skylark (*Alauda arvensis*), recorded during 59% of all bird surveys undertaken (Figure 9).

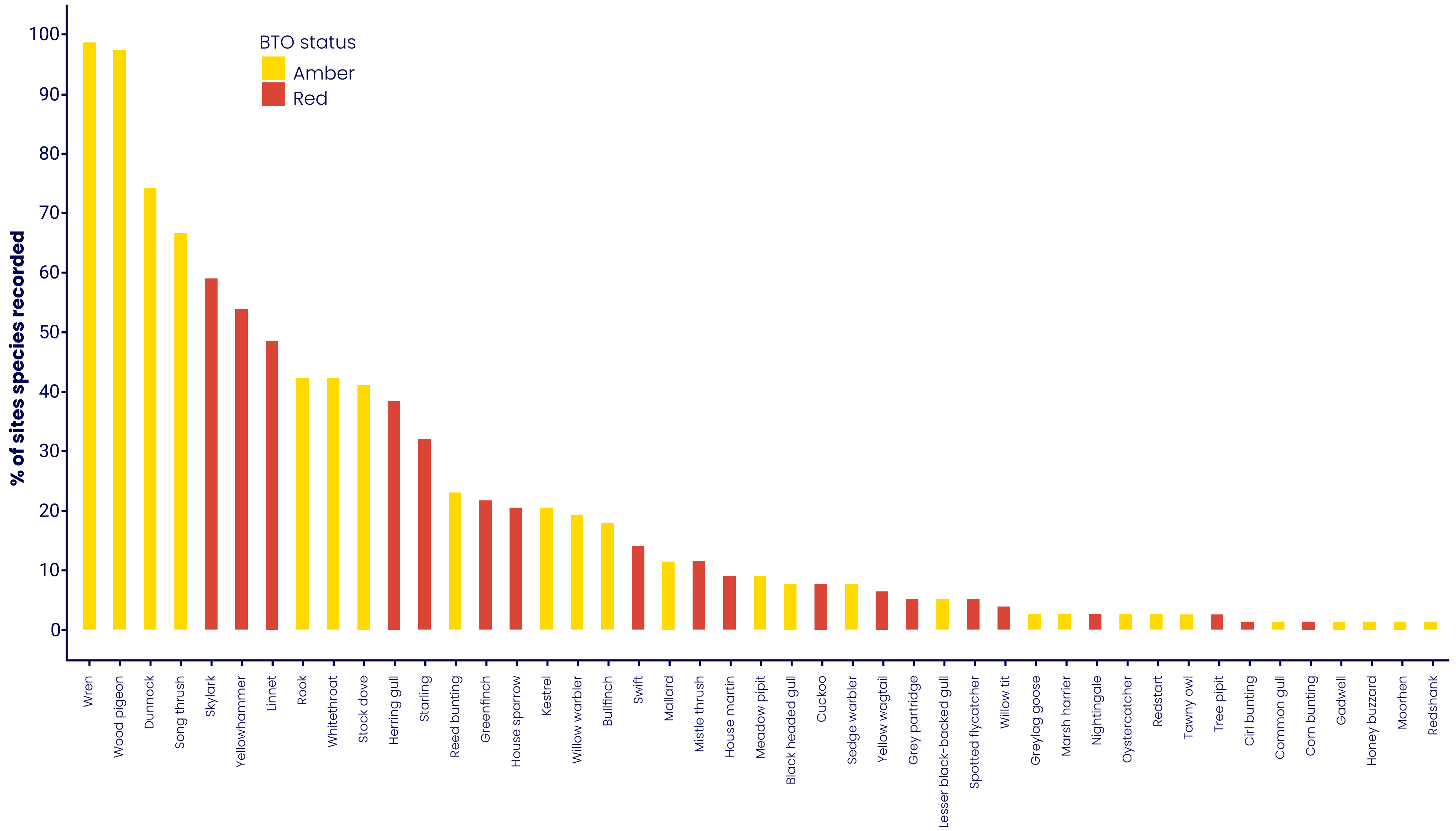


Figure 9. Observation frequency of Birds of Conservation Concern. The percentage of individual bird surveys during which each BTO Amber or Red Listed bird species was observed, arranged by most to least frequently recorded.

Birds continued

Particularly Interesting species recorded during bird surveys included nightingale (*Luscinia megarhynchos*), observed during two surveys at one solar farm and reported as possibly breeding on site. Nightingale is a Red Listed species which have declined in number (42% reduction in population between 1995 and 2022) and range over time and are now only found in small areas in southern and eastern England[22].

Another notable Red Listed species recorded was cirl bunting (*Emberiza cirlus*), observed during one survey at one solar farm. This species also has a restricted range, which contracted by almost 85% between 1968-72 and 2008-11, and is now generally limited to southwest England[23].

On average, 86 individual birds were recorded per survey, but this ranged from eleven to 238. In terms of number of bird species, 22 were sighted per survey, on average, ranging from eight to 39.

There was also variation in bird biodiversity observed at the site level. On average, 93 individual birds were recorded per solar farm, but this ranged from 28 to 238. The number of species sighted also varied, with an average of 22, but ranging from nine to 39. Solar farm scale numbers include only values from one bird survey per site; the second bird survey at solar farms that were visited twice was excluded.

There was some variation in bird diversity with solar farm management, with more individuals and species recorded during surveys at solar farms that were managed with a greater focus on biodiversity (i.e. assigned to Categories 2 or 3; Figure 10). On average, 24 species were sighted at solar farms in Category 2, 21 species at sites in Category 3 and 17 species at solar farms assigned to Category 4. A similar pattern was observed with the number of individuals, with 97 birds observed at solar farms assigned to Category 2, 95 at sites in Category 3 and 58 at those in Category 4, on average (Figure 10).

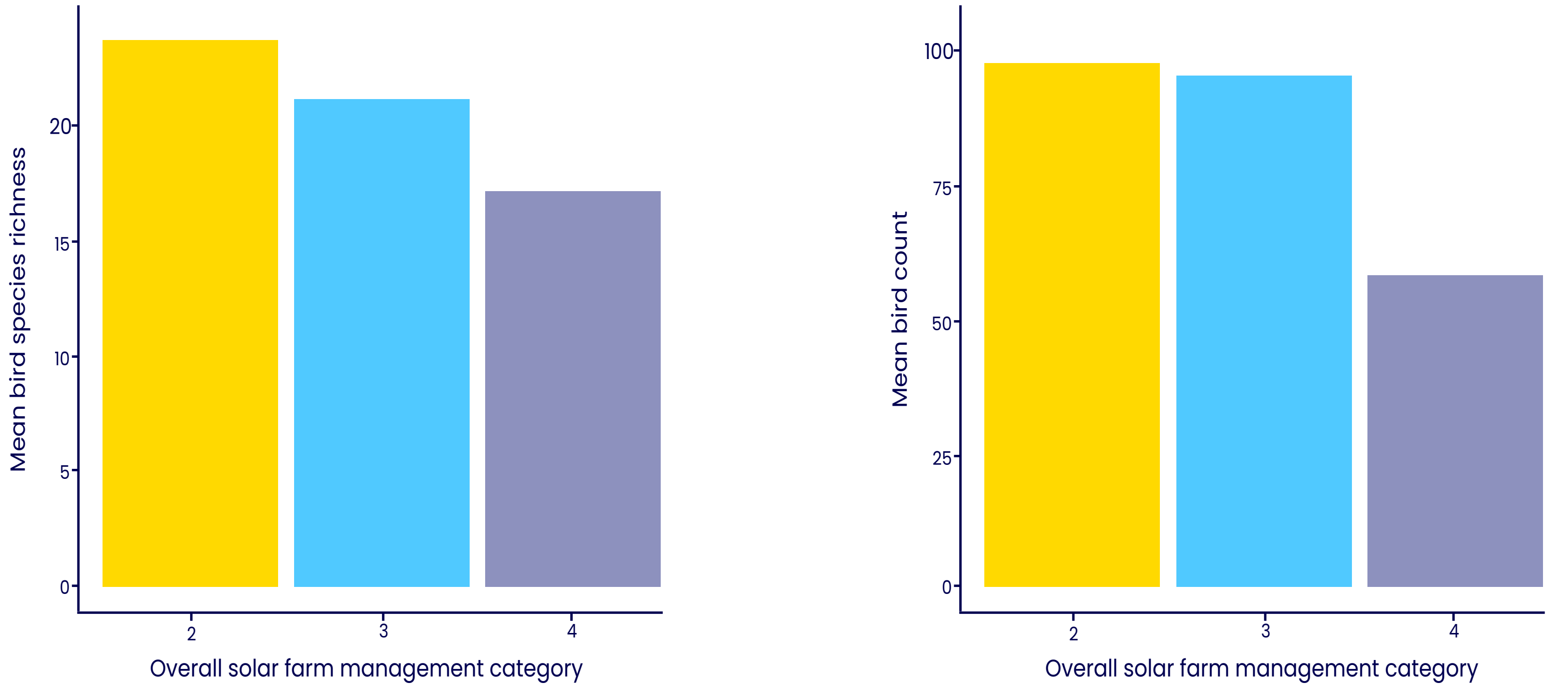


Figure 10. Bird biodiversity by solar farm overall management category. The number of bird species (left) and individual birds (right) recorded during structured bird surveys walked at solar farms assigned to different management categories. Where multiple bird surveys were undertaken at solar farms, only data from the first survey were included.

Incidental observations

Birds were also observed outside of structured bird surveys and incidental observations were noted down by ecologists at 28 solar farms (sometimes alongside structured surveys, but not in all cases). As part of incidental observations, 426 birds were recorded, comprising of 46 different species. As with structured surveys, most species recorded were Green Listed (50%; 23 species), although Amber and Red Listed (both 22%; ten species) were also recorded, as were those which are non-native and so have no status (6%; three species). All species recorded as part of incidental observations were also observed in structured bird surveys, apart from Canada goose (*Branta canadensis*).

Meadow Pipit,
H. Knight-Smith, British Solar Renewables

Stonechat, J. Coppin, RSPB

Case Study

Solar farms managed for nature can boost bird numbers

The possibility that solar farms managed for biodiversity could support birds has been evidenced by a recent study undertaken by the RSPB and the University of Cambridge[24]. Bird populations on six solar farms in the East Anglian Fens were explored by conducting field surveys at solar farms managed in different ways (Table 3) and in nearby arable farmland. Across the entire study, more than 35 km of transects were walked, with 830 individual birds from 44 different species recorded.

Category	Definition
Simple habitat solar farm	Solar farms that were intensively managed, with the grass around the solar array cut or grazed, leading to a short sward throughout the summer.
Mixed habitat solar farm	Solar farms that were less intensively managed and as a result contained more complex habitats, allowing greater sward height and establishment of wildflowers. Woody features, such as hedgerows, were also present.

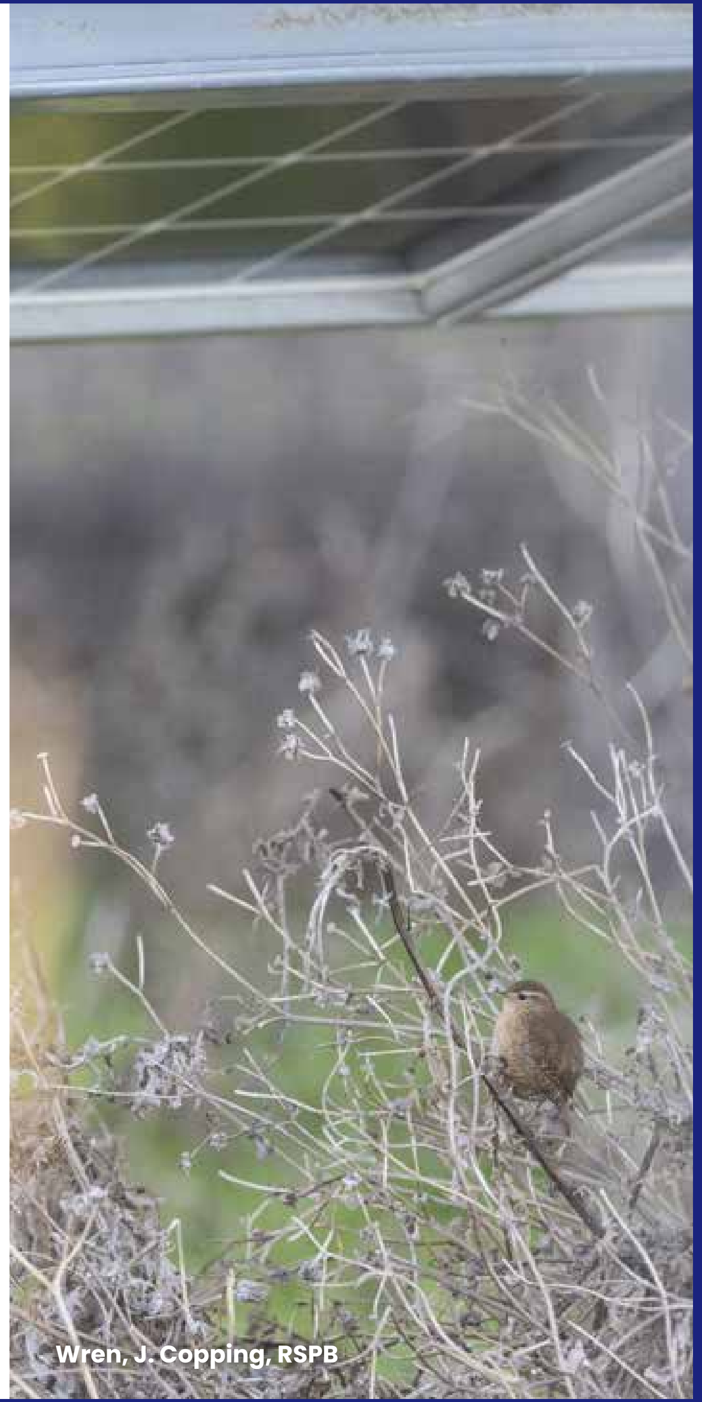
Table 3: Categories into which solar farms were split, based on management, in this study across six sites in the Fens.

Bird abundance and species richness was reported to be greater inside mixed habitat solar farms, i.e., those managed less intensively. This trend was reported across most of the bird species studied and was also clear when birds were split into different groupings, including for farmland and woodland birds, and for threatened species classed as Red/Amber listed Birds of Conservation Concern.

Thinking about the drivers behind these trends, the researchers suggest that well managed solar farms could support bird biodiversity because they have increased floral diversity compared to intensively managed sites or arable land, which provide food resources for birds via seed and invertebrate prey. Alternatively, solar farms may support birds because their presence in certain landscapes can add structural variation via semi-natural habitat features which provide cover and perches for birds. The researchers highlight that the impact of solar farms may differ depending on wider landscape context and sites developed in landscapes dominated by intensive arable agriculture might be more beneficial to biodiversity than those deployed in landscapes that already contain diverse grasslands or other natural habitats.

Careful landscape-scale planning is still needed to ensure solar farms are developed in suitable areas, away from nature-sensitive areas. However, if managed with biodiversity in mind, this study echoes the notion that solar farms can provide relief for birds from the impacts of intensive agricultural practices in the surrounding landscape.

To help realise these benefits on the ground, the RSPB is working in partnership with solar businesses Lightrock Power, Econergy and Elements Green to help ensure a positive outcome for nature and to support the integration of best practices for nature into the management of their sites.



Wren, J. Copping, RSPB

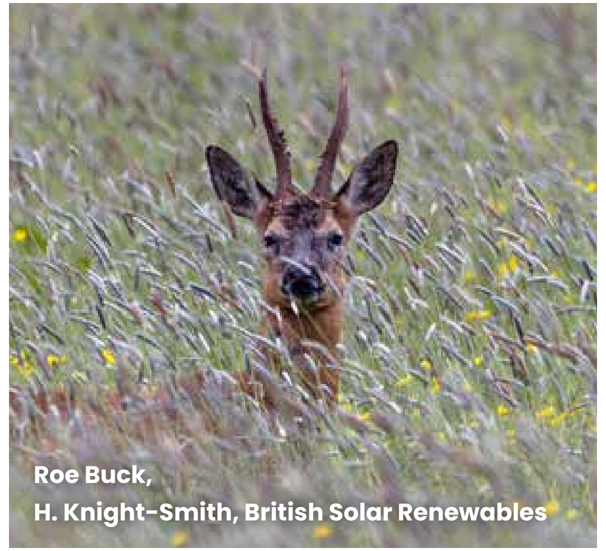
Roe Deer, H. Knight-Smith, British Solar Renewables

Mammals

Incidental observations

Although targeted surveys for mammals were not undertaken at most solar farms, ecologists noted down any mammals they observed, or saw signs of (such as scat, footprints or feeding remains), whilst carrying out other surveys. Mammal observations were made at 22 sites (18%), with eight species observed or signs of their presence recorded. These included badger (*Meles meles*), fox (*Vulpes vulpes*), brown hare (*Lepus europaeus*), rabbit (*Oryctolagus cuniculus*) and common shrew (*Sorex araneus*). Muntjac (*Muntiacus reevesi*) and roe deer (*Capreolus capreolus*) were also sighted. At one solar farm, droppings and feeding remains of water vole (*Arvicola amphibius*) were noted, which is listed as endangered on the Red List for British Terrestrial Mammals because of population declines over time[25].

Incidental observations provide only a snapshot of the mammal biodiversity that can exist within solar farms and to gain a better understanding, targeted approaches are needed.



Roe Buck,
H. Knight-Smith, British Solar Renewables

Soils

Soil conditions and properties reflect the types of habitats that can be supported above ground. Soil samples can be collected to track any changes in nutrient levels and general soil health over time. High nutrient levels can be a limiting factor to habitat creation (e.g. wildflower meadow creation) and can guide appropriate management to work towards creating suitable conditions prior to applications of expensive seed mixes. If soil properties and conditions are known this can also inform an appropriate seed mix and support a site-specific approach.

Soil sampling

Soil samples were taken at 35 solar farms, and this typically involves using a soil corer to collect samples within one of the fields.

Several challenges were identified when collecting soil samples. On some sites, samples were not taken due to concerns about underground wiring damage. Where samples were taken, the corer was only utilised between panels due to health and safety concerns associated with taking samples under panels or in the edges of the site (where security camera cables can be buried). Additionally, the sampling methodology is designed to be focussed on a single field so in many cases, the entire site was not sampled.

Laboratory analysis

Once soil samples have been collected by ecologists, they are sent off to external laboratories who run a range of tests to assess soil properties. For most solar farms, a range of data were available which can inform future management and provide insights into soil health (Table 4).

Soil property	Application
pH	Can be used to inform future seeding or planting.
Phosphorous content	A key limiting nutrient when establishing a diverse grassland.
Potassium content	A key limiting nutrient when establishing a diverse grassland.
Magnesium content	Useful to inform grazing regimes.
Total nitrogen	A very variable nutrient which can also limit plant diversity when levels are high.
Organic matter	An overall measure of soil health.
Total organic carbon	An overall measure of soil health.
Carbon nitrogen ratio	Higher ratios are typically associated with more soil fungi and slower decomposition of organic matter.
Soil texture	Insights into the proportion of sand, silt and clay can be useful to inform seeding and planting.

Table 4. Soil properties and how they can inform solar farm management. Soil properties that can typically be assessed after running laboratory tests and their applications for use when managing solar farms.


Soil, H. Blaydes, Lancaster University

Case Study

Promoting soil carbon on solar farms

Land use change has resulted in substantial losses of soil organic carbon (SOC) globally, and the current drive to convert agricultural land to ground-mounted solar farms offers risks and opportunities to enhance soil's role in climate, food, and human security. The goal of increased SOC storage to combat climate change has received much attention in recent years, partly due to its other known benefits (e.g. water quality, food security).

Solar farms can play a crucial role in addressing global soil issues by promoting healthy soils and, in particular, SOC storage and sequestration, which are essential to mitigate climate change, support food production, and promote biodiversity.

Despite the significant impact solar panels may have on plant biomass production and soil carbon[26], solar farms can promote SOC through a range of design, construction, and management options that are fully compatible with solar farm development and operation.

A recent review of the scientific evidence from the UK and Ireland[27] has revealed land management practices that offer potential to deliver net soil carbon gains within solar farms in the UK:

1. **Designing solar farms to deliver positive outcomes for plants and soils** (e.g. by increasing the height of solar panels or the proportion of areas not over-sailed by panels to reduce the negative effects of shading on plant productivity). However, these would likely result in increased land take for solar farms, with overall outcomes dependent on the type of land use being converted.
2. **Adopting construction practices that minimise impact on soils** (e.g. by favouring the use of low-impact vehicles to minimise soil compaction during construction and operation).
3. **Increasing plant species richness and the diversity of plant functional groups**, including those commonly associated with increased soil carbon sequestration (e.g. legumes) and those tolerant to shading (to cope with conditions found underneath solar panels).
4. **Improving grazing management through low-to-moderate intensity grazing and rotational grazing** (i.e. rotating livestock to allow the land to rest).
5. **Applying organic fertilisation tailored to site conditions**. Moderate levels of organic nutrient addition, particularly cattle slurry and biosolids, often results in positive outcomes for grassland soil carbon storage in the long term, especially if combined with other management options (e.g. rotational grazing), however, higher nutrient contents can promote lower plant diversity.

The wide temporal and spatial variability in soil conditions in agricultural systems, as well as the highly contextual nature of the effects of land management on soils, make devising general recommendations challenging. Therefore, design, construction, and management strategies must be optimised for each solar farm to accommodate site specific conditions. Positive results will most likely be realised if conversion is from degraded agricultural land or brownfield sites.

Importantly, regular monitoring using standardised approaches[28] will be key in evaluating the success of any intervention to support healthy soils, and help inform scientific research, land use frameworks, policy development[29], and industry best practice.


Soil sample, H. Blaydes, Lancaster University

Looking ahead

Solar Habitat 2025 marks the third annual edition of the Solar Habitat report, reaffirming that well-managed solar farms can positively contribute to biodiversity. Whilst the importance of substantiating this conclusion with evidence each year remains, the industry is committed to continuously enhancing the depth of our analysis by exploring new ways to strengthen the insights from the data collected.

Methodology update

The Standardised Approach to Monitoring Biodiversity on Solar Farms has been applied on 248 occasions across three years, according to the data submitted for analysis in Solar Habitat, and may well have been used more widely. Building on their experience in the field and looking at how solar farms are changing the authors have identified ways that the methodology can be improved and adapted to an evolving industry. As the data sets grows, we anticipate further research, including examination of temporal trends.

Site numbers and third parties

The number of sites surveyed each year has grown from report to report. In the first and second Solar Habitat however, though data was collected on sites representing multiple site managers and owners, the ecologists conducting the monitoring and submitting the data has been the two ecological consultants involved in both developing the Standardised Approach and authoring Solar Habitat. For the number to continue to grow and cover a greater share of active sites across the country it will be necessary for additional ecological consultants to use the methodology and submit data to the report. This year, data has for the first time been supplemented by a third party ecological consultant, Envance.

The Standardised Approach was developed for industry-wide use, and we strongly encourage all consultants conducting ecological monitoring on solar farms to adopt it. We look forward to increased participation from ecological consultants in the future.

Identifying deeper trends in the data

Lancaster University have been conducting a deeper analysis of the data from 87 sites collected in 2023. It is hopeful that this analysis could identify relationships and management types which have been effective in promoting biodiversity on solar farms which have not been picked up in the regular analysis in the report. As well as that we hope that this will identify areas of analysis which could add depth to future Solar Habitat reports. As the data sets grows, we anticipate further research, including examination of temporal trends.

Citizen science

Over the past year the project partners have held discussions with Non Government Organisations (NGOs) engaging volunteers to conduct monitoring of birds and invertebrates. Enabling volunteers to access sites to conduct in depth bird or invertebrate studies on solar farms, potentially including more than one visit in a year, could add clarity to our understanding of how they behave on solar farms. The project partners will continue to discuss how this could be achieved and aim to pilot a volunteer monitoring scheme on a solar farm.

Exemplar solar farms

The authors have discussed the possibility of developing a small number of 'research intensive' sites. This would enable more extensive biodiversity assessments and allow ecologists to target sampling days suitable for certain groups. Moreover it would enable more groups to be assessed and multiple visits in one year to capture known variations in species throughout the year. Such sites impact of seasonal and daily weather fluctuations on the usual one-day surveys, by conducting longer, targeted studies, possibly with multiple visits in the year to test out the trends identified in the larger data set. Such sites could also be suitable places to test innovations in monitoring techniques, such as automated monitoring technologies.

Kestrel, H. Knight-Smith, British Solar Renewables


AgriSound Polly, H. Blaydes, Lancaster University

Case Study

Automated monitoring of biodiversity at solar farms

Novel technologies are emerging that can be used to monitor biodiversity which are less time demanding than traditional surveys and capture data at much more frequent intervals. Often using acoustics or image-based analyses, devices can be deployed in an area of interest, such as a solar farm, and left to collect biodiversity data. Compared to one day field surveys, which are often only able to capture a snapshot of biodiversity present on a single day, continuous monitoring that collects data over longer periods can provide different insights into biodiversity. Monitoring over longer periods of time also means that results are less likely to be impacted by weather conditions, which can strongly influence outcomes of single visit field surveys.


AMI trap,
H. Blaydes, Lancaster University

A range of automated monitoring techniques have been trialled at Westmill Solar Park in Oxfordshire to assess the activity of invertebrates, birds and bats, in a study led by Lancaster University.

Although similar techniques have been used in agricultural settings, this is the first time that this combination of technologies have been deployed in tandem in a renewable energy setting. It is hoped that these technologies will help to further understanding of biodiversity response to solar farms habitats.

The study was supported by Low Carbon and the UKRI Engineering and Physical Sciences Research Council.

The different technologies used were:

AgriSound Pollys

These devices use acoustics (based on the wing beat frequency of invertebrates) to assess bee and hoverfly activity[30].

Automated Monitoring of Insect systems

Developed by the UK Centre for Ecology & Hydrology, these traps use lighting to attract moths along with a high-resolution camera to assess moth activity and biodiversity based on the images captured[31].

SongMeters

Acoustic devices with multiple microphones that record bird and bat calls, giving insights into activity and species present[32].

Songmeter, H. Blaydes, Lancaster University

Contributors

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Resources and Footnotes

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