SOLARVIEW

ECOLOGICAL MONITORING OF SOLAR SITES
OVERVIEW OF 2019 SURVEYS

CLARKSON & WOODS
ECOLOGICAL CONSULTANTS

Medium Consultancy of the Year
CIEEM AWARDS 2019 WINNER

Welcome to the overview report of all solar sites monitored by Clarkson & Woods in 2019, or the 2019 'Solarview'. The second such report outlining the results of our ecological monitoring.

Clarkson & Woods continue to monitor a large number of ground mounted solar PV sites across the country and our Solarview publication amalgamates this monitoring data in order to look at trends.

The aim of this report is to look at how wildlife is affected by solar farms (and so inform future impact assessments) and explore how successful different forms of management are (and so can inform the development of management plans). We hope that this report will be helpful for site operators, local authorities, ecologists, farmers and the solar trade industry alike.

This report is not intended as an in depth scientific analysis however, the large dataset we have gathered as part of this work provides us with an exceptional opportunity to produce an overview on how solar farms might be influencing the biodiversity on the sites in which they are located. In addition we hope to inform management practices so that they are more effective and cost efficient. We intend to produce further annual reports as additional data is gathered in order to further explore these areas. Of course the main limitation with this study is that the sites we monitor represent only a proportion of those that exist within the UK and a large number of sites go completely unmonitored. The sites that we monitor are the ones which have an ecological management plan in place and so are more likely to have ecologically driven management. Until the dataset can be expanded and ecological monitoring becomes the norm for solar sites, it is impossible to get true averages and fully assess impacts associated with solar sites. For this we rely on solar companies to organise ecological monitoring and Local Planning Authorities (LPAs) to enforce the requirement within the management plans.

All data and photographs used within the report have been gathered during ecological monitoring of solar farms by Clarkson and Woods and has been anonymised, excepting the case studies presented.

If you have any queries regarding this report or have any sites which you would like us to add into our monitoring portfolio and include within next years' Solarview report, please feel free to contact Tom Clarkson or Belinda Howell.

A diverse grassland establishing within a solar farm

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Clarkson & Woods have been monitoring large scale ground mounted photovoltaic solar farms (for the purposes of this report, this includes all sites above 3MW) since 2014.

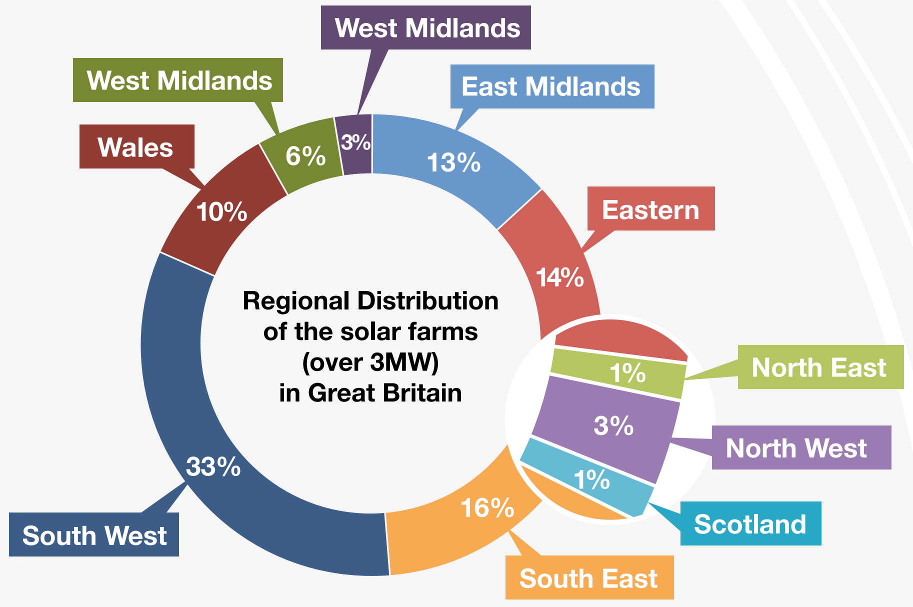
Our portfolio of monitoring sites comprises approximately 10% of all British mainland solar farms[1]. In 2019 we monitored 3% of the GBs sites (30% of our portfolio) as at many sites monitoring is not required on an annual basis, but rather follows an intermittent schedule.

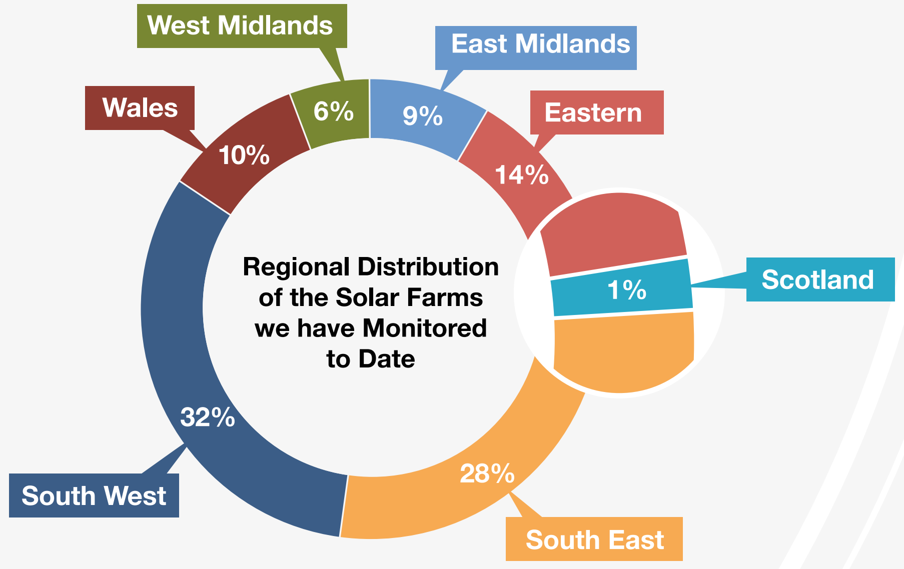
Over the last 6 years we have developed a standardised botanical monitoring protocol which uses quadrat surveys within different areas of the solar farm; this provides us with a comparable dataset. While on site we also conduct a general walkover survey, taking ad-hoc recordings of plants, invertebrates, birds, mammals and anything else of interest. In addition to these surveys, we inspect installed bat and bird boxes. Some sites have more bespoke requirements including breeding bird, dormouse, great crested newt, bat, reptile and fungi surveys.

As the adjacent map shows we monitor sites across England, Wales and into Scotland with approximately 60% of those sites in southern England, reflecting the national distribution of ground mounted PV arrays.

1 Renewable energy planning database monthly extract – December 2019 https://www.gov.uk/government/publications/renewable-energy-planning-database-monthly-extract last updated 14th January 2020.

33% of operational solar farms are located in the South West and 16% in the South East, as represented in the pie charts below. While proportionately the distribution of sites we have monitored is broadly in line with the industry for the South West, the East, West Midlands, Wales and Scotland, we have monitored a disproportionate number of solar farms in the South East and have yet to monitor any of the farms in the North East, the North West or Yorkshire and Humber.





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Grassland Management

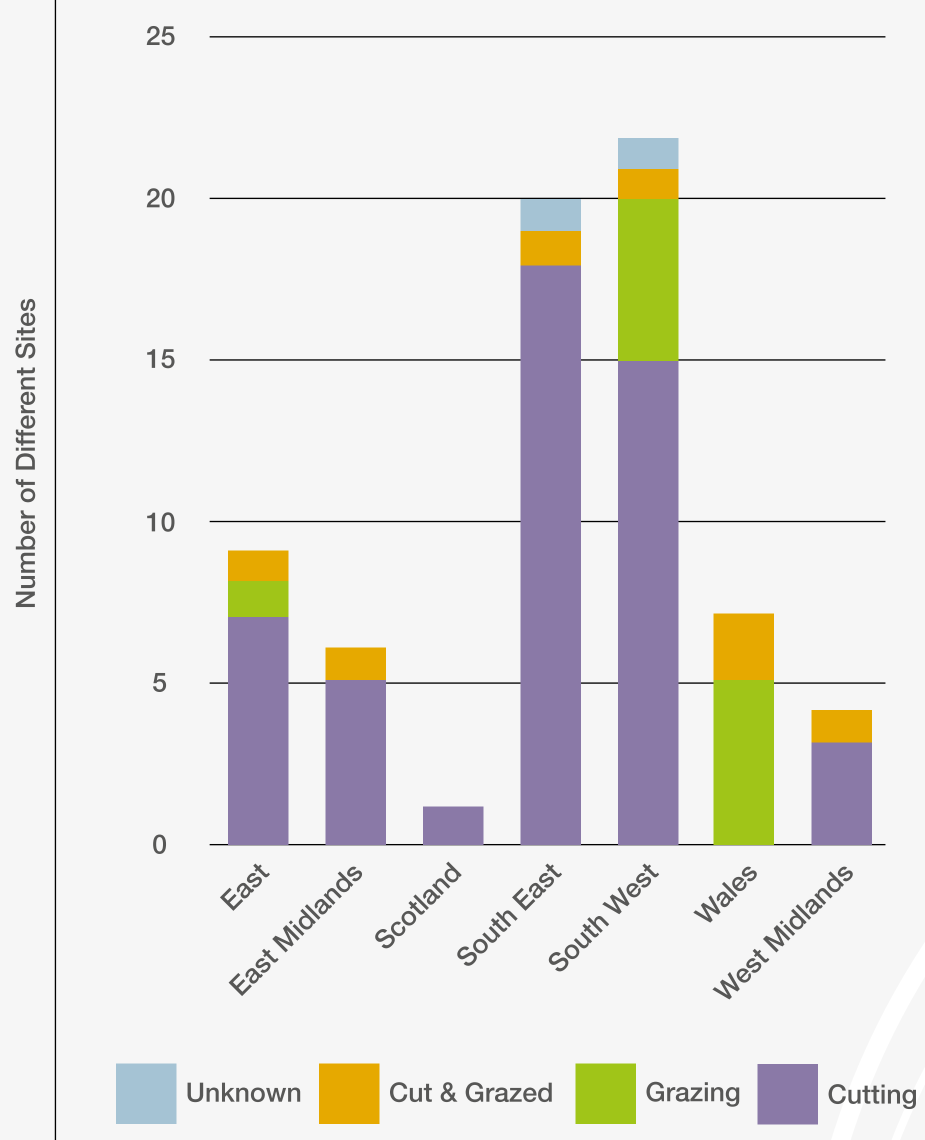
Management of grassland within a solar farm often represents a considerable cost, is the trickiest aspect of management to get right and is the most important in terms of supporting a wide range of other species.

Over the years we have found regional differences in the management of solar farms, as shown in the graph on page 6.

For example, all the sites we monitored in Wales were sheep grazed for at least part of the year; a trend which isn't represented elsewhere. Despite this, a large number of management plans continue to specify sheep grazing as a management tool, which may not be practicable for some sites.

Sheep grazing within a solar farm during the summer months

All Sites Monitored: Management by Region



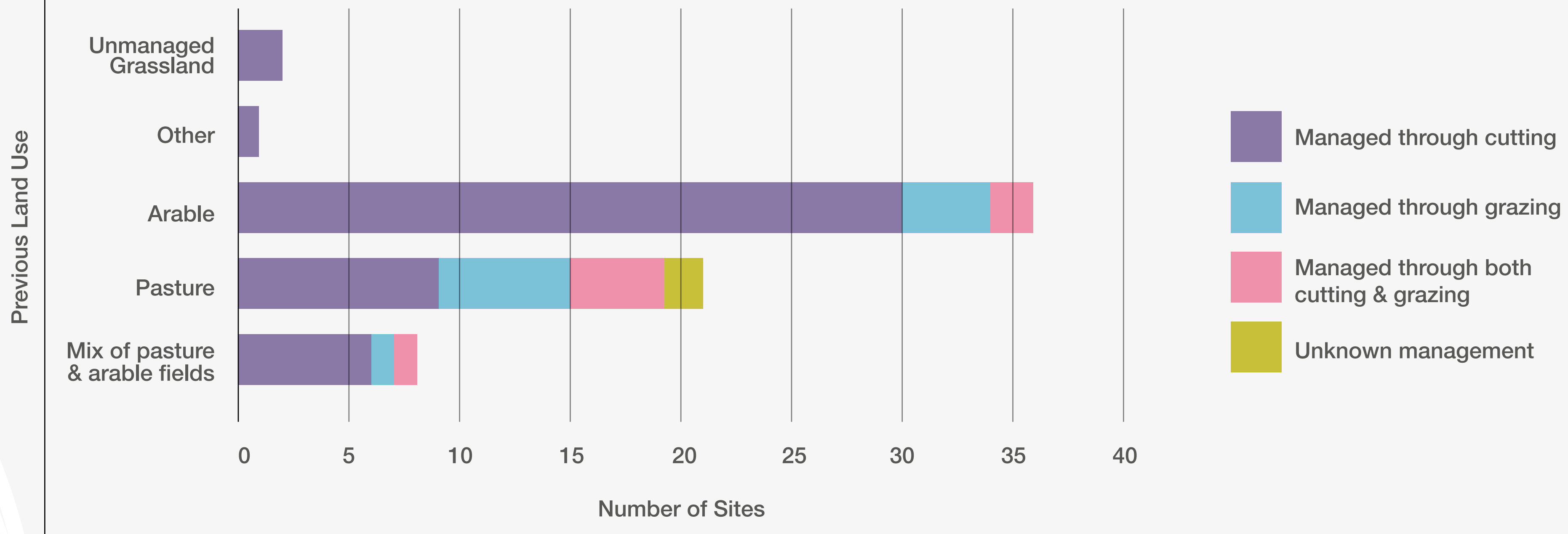
Overall, 26% of sites monitored are sheep grazed to some extent, and 71% of sites are cut. However, when looking at sites monitored in 2019, 57% were sheep grazed to some extent. This may be due to the smaller sample size. However, we have found that some management companies are looking at moving to sheep grazing now that the grassland sward has become established. We will continue to monitor the approach to management across our portfolio of sites and will report on any changes in management practices within the 2020 Solarview.

It is worth mentioning that most management plans specify the removal of sheep from the solar farm during May-August to allow flowers to set seed and reduce disturbance to ground nesting birds. Whilst it is difficult to assess management for the times of year we are not undertaking ecological monitoring, it appears that the requirement to remove grazing during the key flowering season is not always adhered to.

Many management plans also specify the removal of arisings after cutting as this decreases the nutrients in the soil, helping to diversify the grassland and also preventing a thatch from forming which can stifle plant growth. We have found this practice to be undertaken on only a handful of sites, as it is often considered impractical due to the large amounts of grass clippings which need to be collected and then disposed of. Where we have encountered the removal of arisings they are collected for silage. We have yet to look at the implications of arising removal on botanical diversity as it is such an infrequently encountered management practice, despite the frequency of the recommendation.

The regional differences in management may also reflect the differing farming practices in various parts of the country. For example, farmland which was sheep grazed prior to the solar farm installation are more likely to be sheep grazed after the installation of solar arrays. As shown in the graph below, regardless of previous land use the majority of sites are managed through cutting, although former pasture sites are more likely to be managed through grazing/a combination than the other sites.

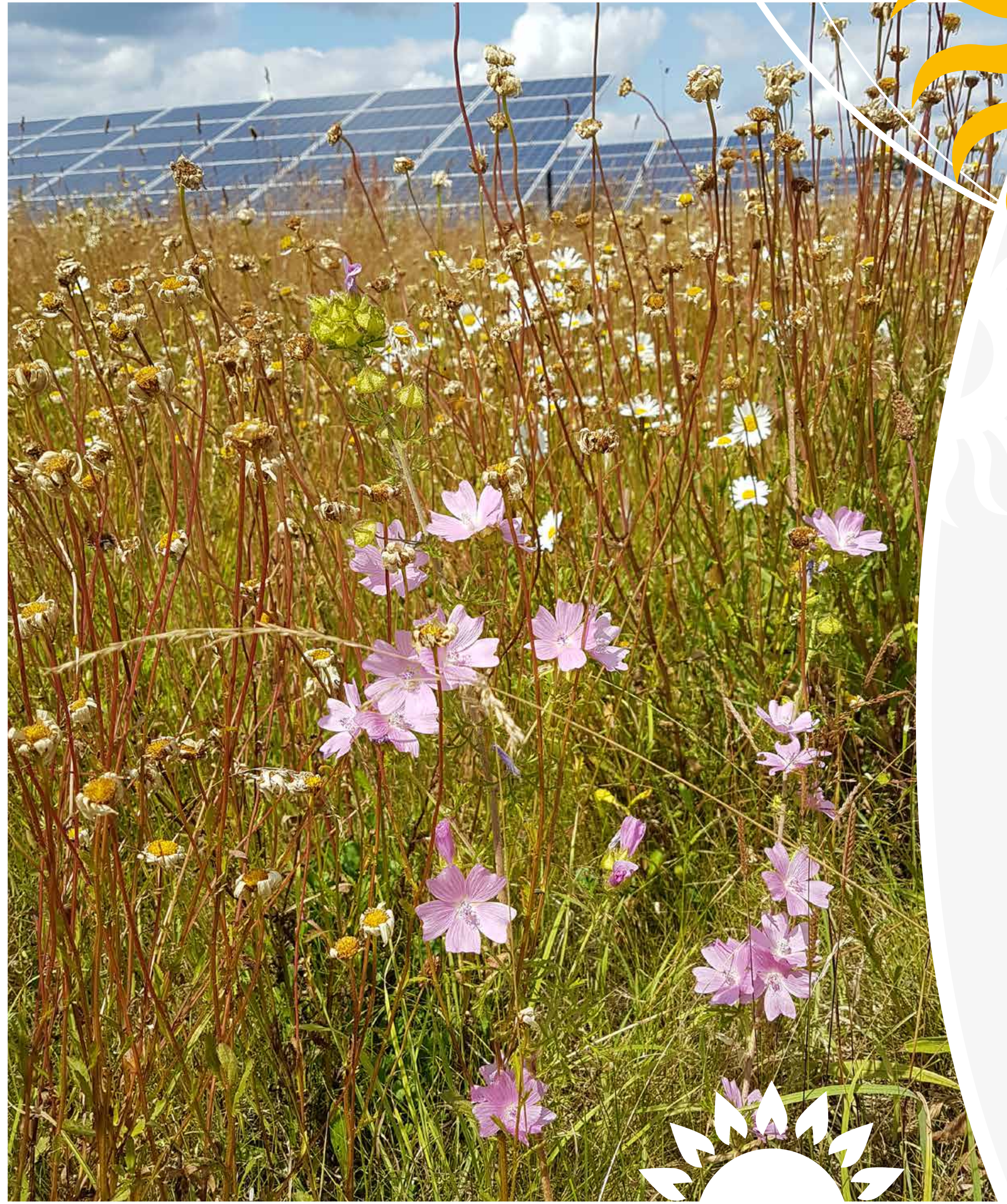
All Sites Monitored: Previous Land Use Compared with Current Management



Another commonly encountered management practice is "shade-cutting", which entails a strip cut directly in front of and behind the panels during the summer to facilitate access and prevent shading. This approach strikes a good compromise between the desire to maximise biodiversity on the site and the need to ensure the efficient operation of the panels. A mosaic of heights is created, the operation of the solar farm is not impeded and the majority of habitat within the site can remain unmanaged for the remainder of the summer.

Arisings from cutting left in-situ

A diverse solar farm with a shade cut 50cm in front of the panels



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Botanical Diversity

We have measured 1,481 botanical quadrats within solar farms over the last four years. Within these we have recorded 65 graminoids (grasses, sedges and rushes) as well as 240 broad-leaved species; including orchids, ferns and tree saplings.

In 2019 alone, we recorded 39 different graminoid species and 149 broad-leaved plants.

For the majority of sites we use a standardised methodology; taking five randomly selected 2m x 2m quadrats directly below panels ("beneath" quadrats), five between the strings of panels ("between" quadrats) and five between the edge of the solar farm and the bounding security fence ("exterior" quadrats) which allows us to look at differences across the site.

A successfully seeded solar farm with an abundance of flowering plants

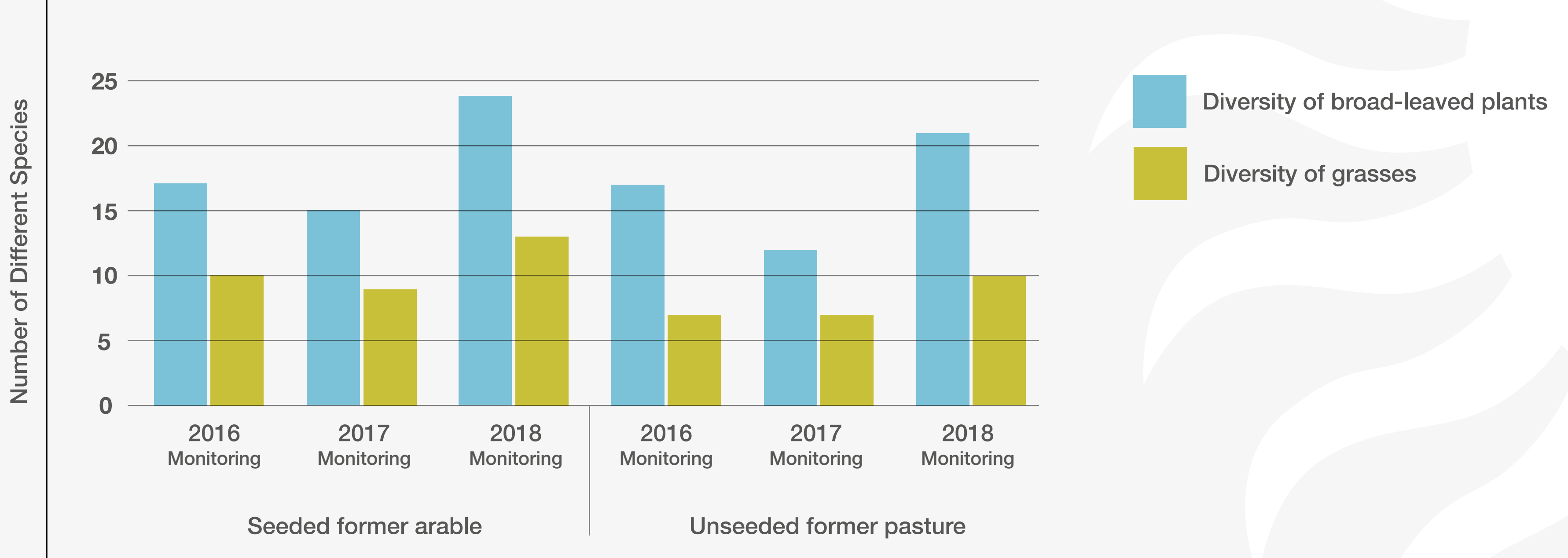
For sites with repeated monitoring requirements this standardised methodology enables us to look at how the site is establishing over time and success (or otherwise) of management.

Our monitoring in 2019 indicates that solar farms created on previously arable land are more diverse than sites created on previously pasture land. The greatest diversity was however recorded on solar farms which previously supported a mixture of both arable and pasture.

We have found that on average previously arable sites (52% of the sample) supported an average diversity of 26 different species including 17 broad-leaved species. It seems likely that this reflects the seeding undertaken at these sites. Pasture sites had a slightly lower diversity (22 different species with an average of 13 broad-leaved species). This may be reflective of the relatively early point in monitoring after seeding.

It is anticipated that diversity within all sites we monitor will continue to expand as agricultural enrichment and disturbance by harrows and plough ceases. Potentially those sites which are not seeded will have a more robust, natural seed bank that may be better suited to the local environmental conditions than those arable sites which feature introduced species.

Botanical Diversity of seeded & unseeded fields on a single site



There is some concern about the introduction of non-locally native genotypes into the natural environment and it is for this reason that we advocate, wherever possible, the use of locally sourced seed. Nevertheless we are aware of seed being used within solar arrays which has been brought in from abroad. The effect this will have upon the natural UK genotypes is unclear although we would note that most invertebrates are unlikely to differentiate between British and European flowers!

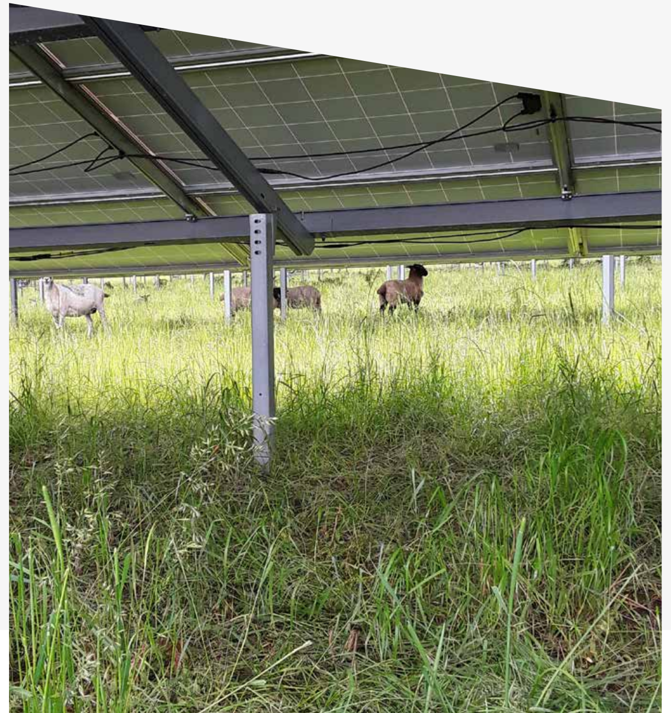
On particularly large sites, or those where seeding/management varies across the site, we undertake double the number of quadrats to compare the establishment of each distinct area. This has been particularly useful in relation to a large solar farm in Cornwall which comprises several formerly arable fields which were seeded after construction, as well as several pasture fields which were left unseeded. We have been monitoring this site since 2015 and have been tracking the development of the grassland sward within both the seeded and the unseeded fields separately. The results are outlined within the bar graph on page 11, showing that both field types are relatively diverse, though the seeded formerly arable fields were notably more diverse during every survey.

A well seeded margin at the entrance to an otherwise intensively managed solar farm.

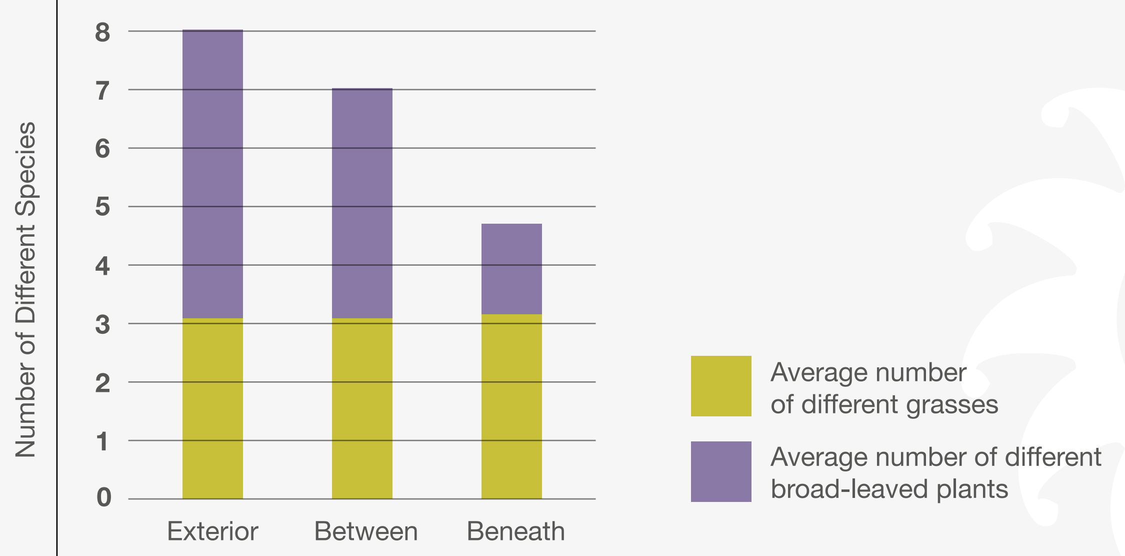
Some of the longest established solar farms have been found to have the highest diversity of plant species. 14 graminoid species were recorded at four separate arrays in 2018, all of which had different management practices and different historic land uses. These four sites did not require monitoring in 2019, however monitoring is planned at these sites in 2020 and therefore we look forward to seeing if there is further evidence of diversification of these sites over time. Currently our data shows only a weak correlation between botanical diversity and time since connection of these sites to the grid, but we hope that in the forthcoming years adding additional data will allow us to further examine this theory. Some of the data collected in 2019 supports this theory with 13 graminoid species recorded at one site where we recorded only 8 species in 2018. This represents an increase of approximately 60% in botanical diversity in a single year. This is a dramatic change and whilst we would not anticipate such a trend will be observed at all sites, we do anticipate that diversification will be a feature of solar farms as they mature.

It does appear that different botanical communities are present within different parts of the site. We have compared quadrats taken beneath, between and around the exterior of the solar farms and found that botanical communities within each area differ slightly. For example yellow rattle, rough hawkbit, evening primrose, field scabious, yellow pimpernel and cuckoo flower were all recorded only within the exterior of arrays and not between or beneath the array strings. Conversely, ferns, charlock, garlic mustard and willowherb species were only recorded

A “Beneath” Quadrat, with sheep sheltering undera djacent string



Average Number of Different Species per Quadrat



beneath the strings. Over the 2019 surveys we recorded 135 different plant species in the “exterior” quadrats, 116 different species in the “between” quadrats and only 103 different species “beneath” the panels. This variety of species and the different diversities within a single solar farm creates a mosaic of conditions which can support a wider diversity of species and may thus be of greater importance to wildlife.

When carrying out impact assessments, we are often challenged by claims that grass fails to grow beneath panels, and as anticipated (and as highlighted in the 2018 Solarview), shading does appear to affect the development of grassland vegetation. In 2019 and previous years the quadrats beneath the panels were the least diverse, with an average of 4 different species per quadrat, compared to the those within the array exterior which had an average of 8 different species.

Of the “beneath” quadrats surveyed in 2019, 75% contained some extent of bare ground, while bare ground was only recorded in 39% of the “between” quadrats and 34% of the “exterior” quadrats. This variation appears to be less pronounced on former pasture sites compared to arable sites which likely reflects the difficulty in establishing grassland on bare ground within shaded areas. This suggests there may be merit in considering seeding sites prior to the solar farm installation on previously arable sites. Grassland would be easier and cheaper to establish at this point and potentially might help to reduce the damage caused to soils during construction on bare ground.

The presence of bare ground within arrays is not necessarily a negative characteristic. Bare ground can provide an important habitat for a range of species, particularly invertebrates and ephemeral and annual species such as rare arable weeds which may struggle to grow in areas with established grasses. Out of the 400 botanical quadrats we undertook in 2019, only two were completely bare of vegetation and both were “beneath” quadrats. The two bare quadrats were recorded at different sites and all other “beneath” quadrats at either site had between 5-7 different species and an average of 15% bare ground. On one of these two sites the grassland beneath the panels had diversified considerably from an average of 1.8 different species per quadrat in 2018 to 4.6 in 2019.

Case Study: Botanical Diversity

Merston Solar - Solarcentury

A ~7ha former arable site which had previously been perfectly average in terms of botanical diversity (26 different species recorded in 2018). Following the 2018 monitoring the cutting schedule was slightly amended, enabling the sward to develop further. In 2019 we recorded 41 different species (33 different herbs), making it one of our more diverse sites! Characteristic species such as red campion, evening primrose, oxeye daisy and tansy, have been noted throughout, highlighting both the success of seeding by Habitat Aid back in 2016 and the importance of correct management for maintaining biodiversity.

The solar farm and the field margins can vary significantly

SOLARVIEW

Weeds and Undesirable Species

Injurious weeds under the Injurious Weeds Act, 1959 (broad-leaved dock, curled dock, creeping thistle, spear thistle and ragwort) legally require management to prevent spread onto adjacent land. We recorded at least one of these species on 96% of the sites we monitored in 2019.

We have included both common nettle and bramble in this analysis as, although not considered injurious or notifiable weeds, they can create considerable management burdens and dominate in areas.

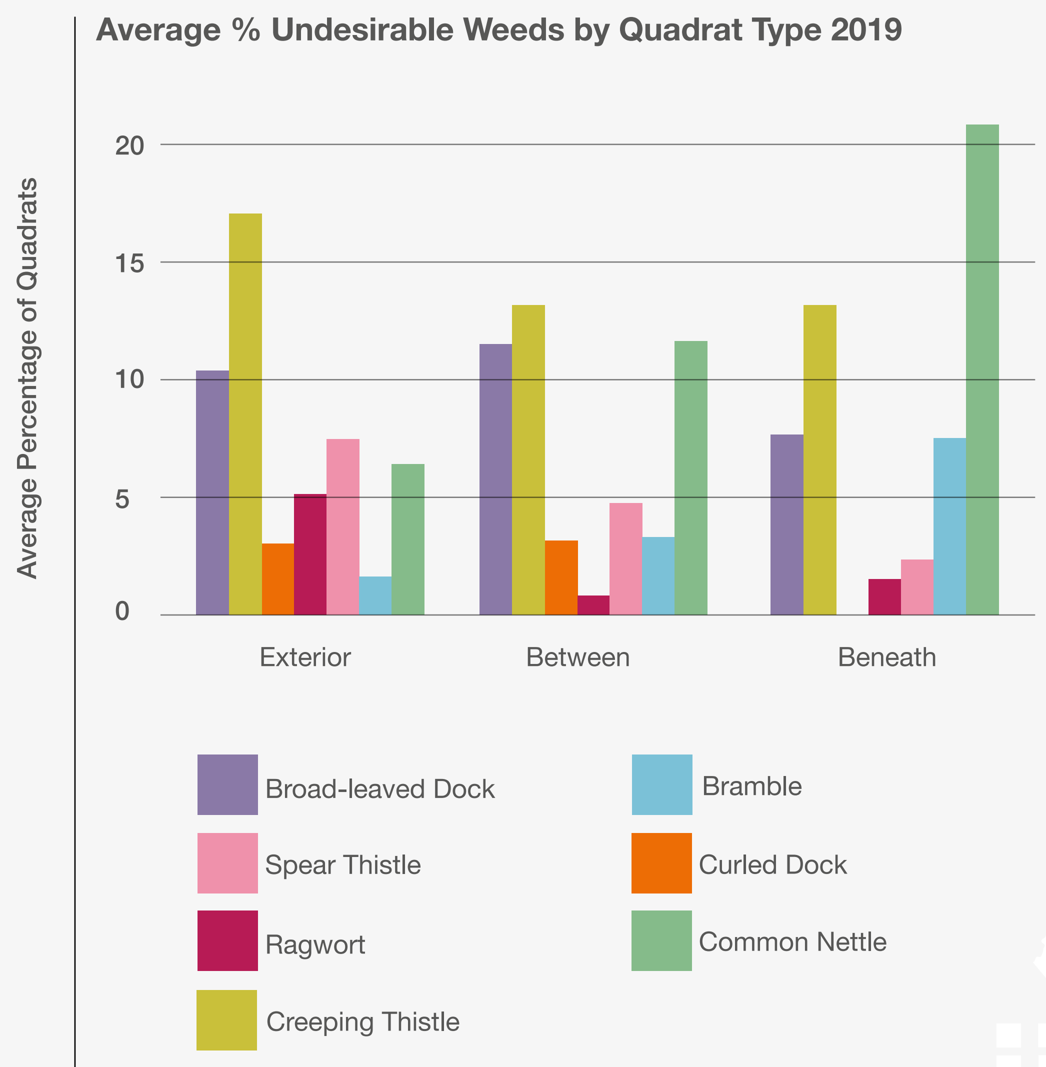
It is worth noting that although in some cases there is a legal requirement to control injurious weeds to prevent their spread, they provide a valuable nectar source for invertebrates and are even key food plants for particular butterflies and moths. For instance the cinnabar moth key food plant is ragwort. Cinnabar moths were recorded on 15% of sites in 2019 and ragwort was recorded on 19% of the sites. Thistles are also primary nectar sources for 10 different species of butterflies and provide a secondary nectar source for a further 26. Nettles are another key food plant for a range of species. Clearly a balance between responsible management of the sites and the biodiversity benefits of species present needs to be struck.

Generally the percentage cover of injurious weeds within solar arrays remains relatively low and is likely to be consistent with those levels recorded in local habitats. As represented within the adjacent bar graph, creeping thistle was the most common and consistently encountered injurious weed.

25% of the "beneath" quadrats taken in 2019 included injurious weeds, while they were recorded in 33% of the "between" quadrats and 43% of the "exterior" quadrats. By contrast the undesirable species (nettle and bramble) were more commonly encountered beneath panels than anywhere else in the solar farms.

14.5% of all quadrats spread over 69% of the sites supported creeping thistle, whereas broad-leaved dock was only recorded in 9.75% of all quadrats but was recorded in over 88% of all the sites. Creeping thistle is a particularly resilient weed which often requires targeted treatment and

Painted Lady butterfly within a solar farm on a creeping thistle (a larval food plant of this species)



can easily dominate where present, whereas broad-leaved dock is more easily controlled, possibly accounting for its lower occurrences despite the increased distribution. It is also worth noting that both species are very common and were likely present on the remainder of the sites but just not recorded within the monitoring survey.

Vigorous shade tolerant common nettles (recorded on 46% of 2019 sites) and bramble (recorded on 3% of sites) can represent a problem when growing under or around the panels, as they can restrict maintenance access, create shading and pose a fire risk. It is assumed that the dominance of common nettles will decline over time due to the gradual reduction of nutrients within the soil, however there is no long term data to confirm this as yet, and is something we are keen to look into.

Bindweed has also been mentioned as a common concern by operators, though we have not yet encountered this species either within our monitoring quadrats or as part of our ad-hoc walkover surveys of sites.

Management of undesirable weeds can be a significant challenge and represents a considerable expense for operators. On some occasions where weed species are prolific, the use of herbicides may be essential to manage the weed problem and ensure that injurious weeds do not spread to adjacent sites (which might represent a breach of the law). Spraying of herbicide under the entirety of the strings has been observed on numerous sites. This kills all broad-leaved plants and subsequently makes the incursions of further problem weeds more likely in the future.

Bramble growing beneath a string – restricting maintenance access

An example of nettle management through topping beneath the panels and collecting of arisings

We have observed herbicides being broadcasted non-selectively across sites which had previously been seeded (at significant expense) with a species-rich seed mix. This resulted in not only the injurious weeds being eradicated, but also all other broad-leaved plants, including wildflowers. Care should be adopted in selecting appropriate treatments for weed species; even the use of selective herbicides such as Grazon will eliminate many of the species deliberately sown. Where impact assessments and biodiversity enhancement strategies have included the creation of species-rich grasslands, management may need to be modified in order to control the extent of injurious weeds without the use of blanket spraying of herbicides. This might include topping of the sward at strategic times of the year, more regular cutting or changes in the grazing intensity. As a last resort, spot spraying or weed wiping may be necessary.

Given the time and expense often put into weed control across sites, we are keen to look at how management practices affect the control or spread of weeds. However, given the large number of variables; providing a detailed assessment of how management affects injurious weeds requires in depth multivariate analysis. As such this is something we are working with Lancaster and York University to look into further. Any comparisons between management strategies are difficult due to the large number of variables; including historic land use, timing of management, whether grazing is removed during key parts of the year, whether a site has been seeded with a diverse seed mix, any herbicide application and the removal or otherwise of arisings etc.

Injurious and undesirable weeds do not require control if they are not spreading to land outside the solar farm and are not causing any maintenance issues. Our botanical surveys have been an extremely useful tool to monitor establishment and spread of weeds and can give an early indication of when management may be required.

2 Injurious Weeds Act (1959 as amended). HMSO, London. https://www.legislation.gov.uk/ukpga/Eliz2/7-8/54/contents

Case Study: **Weeds and Undesirable Species**

Newton Downs – Solarcentury

As is typical of a lot of formerly arable solar farms, the first years' monitoring post construction found high levels of injurious weeds across this site. Following this monitoring survey, efforts to reduce the weeds were made using targeted spraying and topping as well as continued sheep grazing. By the second years' monitoring, injurious weeds which had comprised approximately 15% of the sward in places were now only noted as individuals very occasionally, representing less than 3% throughout. This remarkable decline in injurious weeds was not mirrored by any significant decline in overall botanical diversity, which remained above the average, highlighting the success of management.

An extant SUDs pond adjacent a colar site – valuable habitat for a range of species managed by the O&M for the site

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Birds On Solar Farms

We recorded 65 different bird species during our monitoring in 2019 alone across just 26 sites. Of these, 12 were BTO Red listed Species of Conservation Concern and 15 were BTO Amber Listed.

The recorded species assemblage, shown in the bar chart on page 22, was typical of farmland habitat with a mean of 12.5 different species per survey. This was highly variable, with some sites having as many as 31 different bird species whilst others had as few as 2. It should be noted that these recordings were from ad-hoc observations only and specific bird surveys have not been conducted, therefore a variety of factors may have skewed the results. Nevertheless we believe that the data is useful to examine general trends.

A well seeded field margin with establishing tree planting adjacent a solar farm, providing a valuable wildlife enhancement.

Over the last two years of solar monitoring we have recorded 87 different species; 19 Red Listed Species of Conservation Concern and 18 Amber Listed Species of Conservation Concern. The numbers of Red and Amber listed birds recorded within each site was highly variable, with some solar farms supporting as many as 5 Red listed and 7 Amber listed species, whilst on other sites no species of conservation concern were recorded.

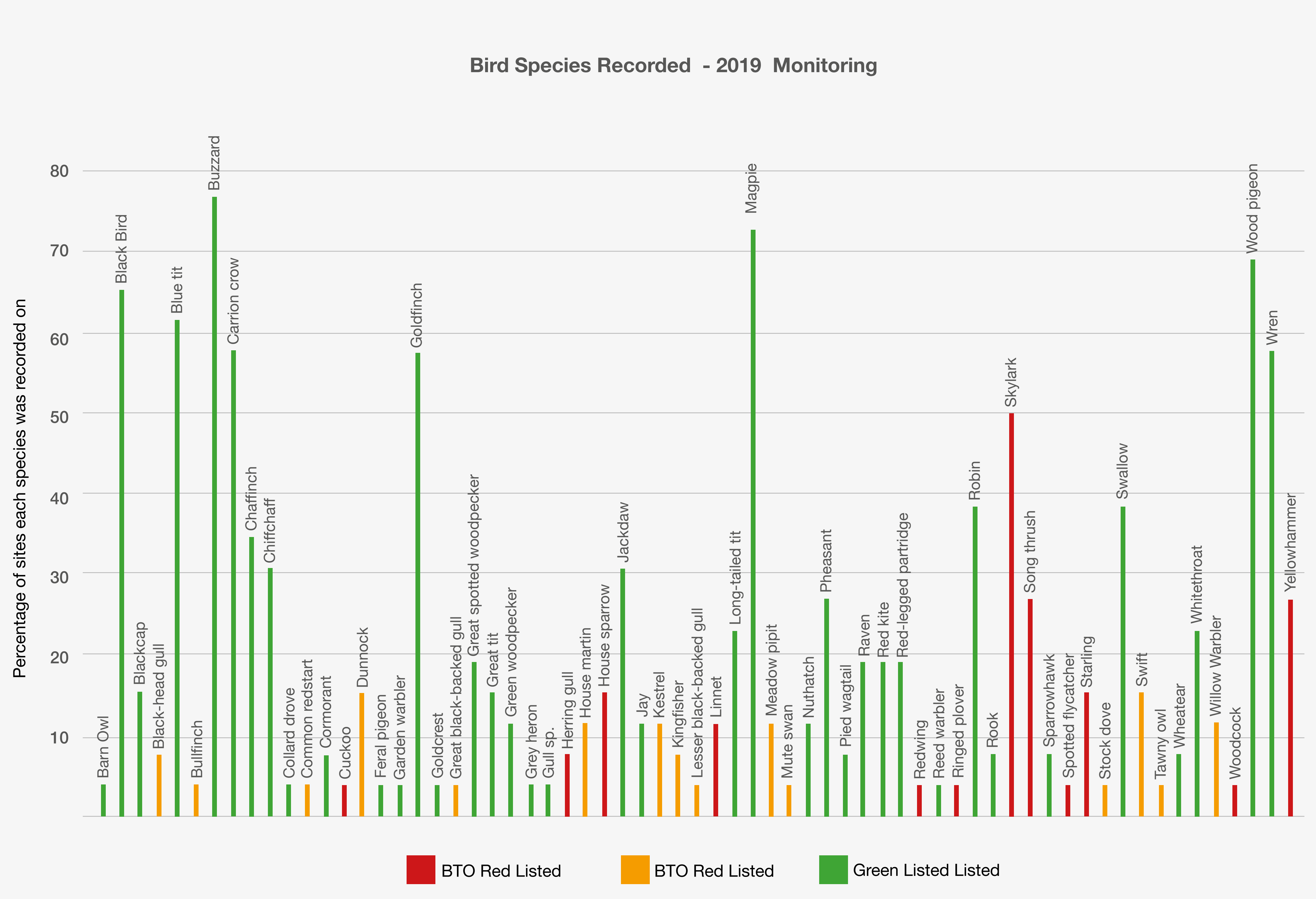
As with the 2018 surveys, the most frequently recorded Bird of Conservation Concern remains skylark, which was recorded on 50% of the sites. Though no nests were found, skylarks were flushed from sites by surveyors walking between the panels, and were noted singing while perched on the panels and foraging within solar farms. Skylarks are ground nesting birds which typically need long sight-lines, therefore it has been wildely assumed that they would be displaced by the construction of a solar farm. Our monitoring shows that skylarks do use solar farms as part of their territory and may use sites for breeding. It is unclear if nesting within solar farms reflects site fidelity (the desire to continue to nest in the same location each year) or evidence that birds do not respond in the manner typically anticipated by ecologists. This would be an interesting area for further research which we hope to pursue.

Skylarks were not the only ground nesting birds recorded using the solar farm interiors, with yellowhammers recorded at 27% of sites. Smaller numbers of wheatear and meadow pipit were also recorded using the sites.

The bar chart shows that a large diversity of birds were recorded during the 2019 monitoring surveys. The most common bird encountered was buzzard (recorded on 77% of all sites). Predatory birds (buzzards, sparrowhawks, kestrels and red kites) were recorded on 92% of all sites monitored in 2019. Ad-hoc notes by surveyors include references to sparrowhawks, buzzards and kestrels foraging within sites, particularly within the field margins where the longer grass offers suitable habitat for small mammals, invertebrates and reptiles.

3 The British Trust for Ornithology (BTO) List of Conservation Concern 4 was updated in 2015; the document reviews the status of birds in the UK, assessing trends in range and population, localised distribution, historical declines, rarity and international importance. The list separated 244 species into red, amber and green levels of conservation concern, with species on the red list being the most venerable or experiencing the greatest decline:

Birds of Conservation Concern 4: the population status of birds in the UK, Channel Islands and Isle of Man. Mark Eaton, Nicholas Aebischer, Andy Brown, Richard Hearn, Leigh Lock, Andy Musgrove, David Noble, David Stroud and Richard Gregory. British Birds 108, page 708–746. Dated December 2015.




A bat box and a barn owl box within a solar farm.

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Ecological Enhancements

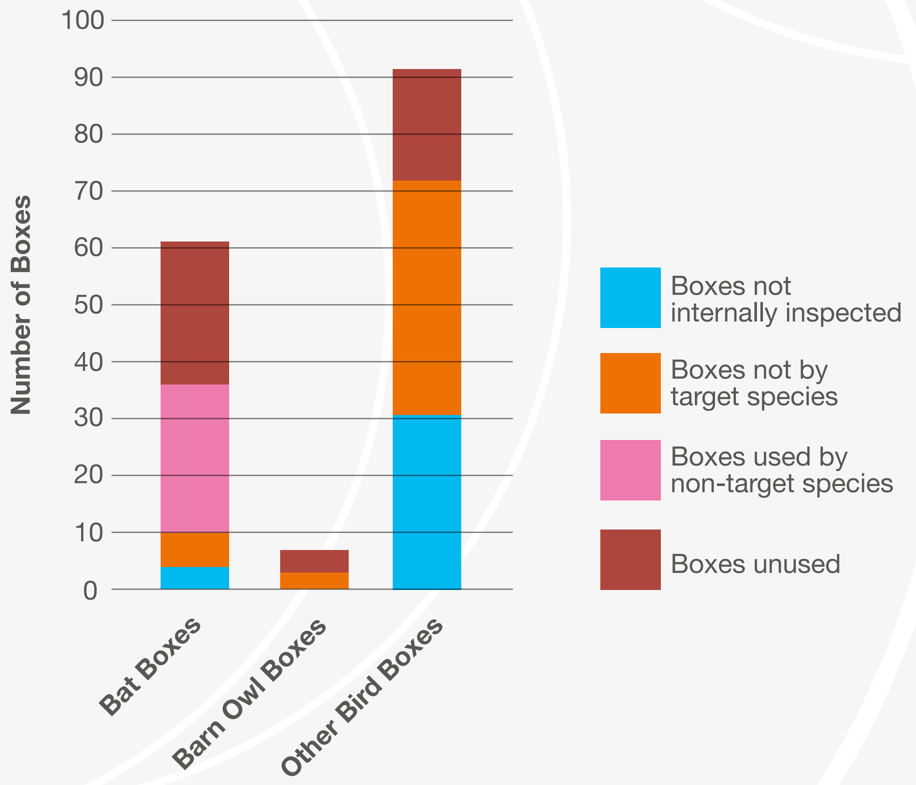
Habitat Boxes

41% of the 119 boxes we internally inspected in 2019 were being used by the target species/taxa. This is a similar success rate to 2018 when out of 400 boxes 40% were used by the target species.

Where bird and bat boxes were recommended within the management plans or ecological reports for the site, these had been installed on 88% of sites prior to the 2019 monitoring visit. The average number of boxes installed within a single site was 5 bat boxes and 5 bird boxes.

In total we found 67 small song bird nests (26 of which were in bat boxes), 3 barn owl nest sites (including nests with chicks), a corvid nest, and 6 bat roosts in 2019. Bird boxes were most likely to be used, with an occupancy rate of 68% in 2019, of which 70% of nests were associated with tit species. 10% of the bat boxes we inspected in 2019 were used by bats with a further 44% of bat boxes used by nesting birds. Additionally 43% (3 of 7) of barn owl boxes we inspected were used by nesting barn owls. In 2018 when we externally inspected 14 barn owl boxes we found an uptake rate of 28.6%.

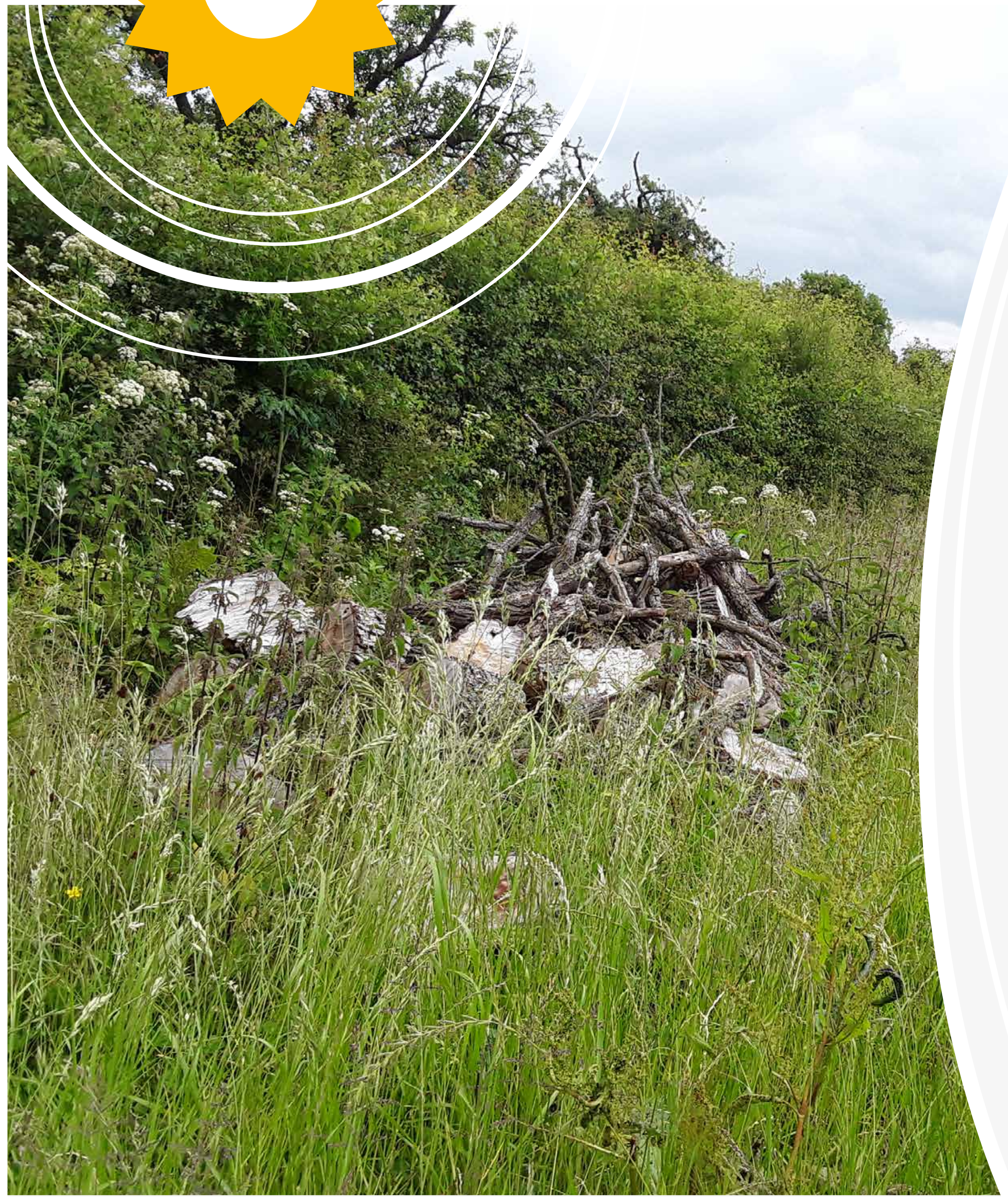
2019 Enhancement Monitoring



Case Study: **Ecological Enhancements**

Berthllwyd – BayWa R.E. Ltd

In 2019 four boxes (24% of those installed) were found to be used by roosting bats. The same boxes were also inspected in 2018, when only two boxes were found to be used. The site has a total of 17 bat boxes, all of which were installed in 2017. The boxes comprise Schwegler 1FD, 2F and 1FW boxes, with only the 1FD boxes found to support roosting bats to date. The reason behind the particularly high rate of box uptake is unclear. It might reflect a lack of natural roosting sites within the surrounding area (although the adjacent large mature woodland makes this relatively unlikely), it may reflect the presence of good foraging habitat within the array and thus an increased level of activity by bats within the area, or it may reflect that this solar farm had a number of mature trees offering ideal locations for erecting bat boxes.

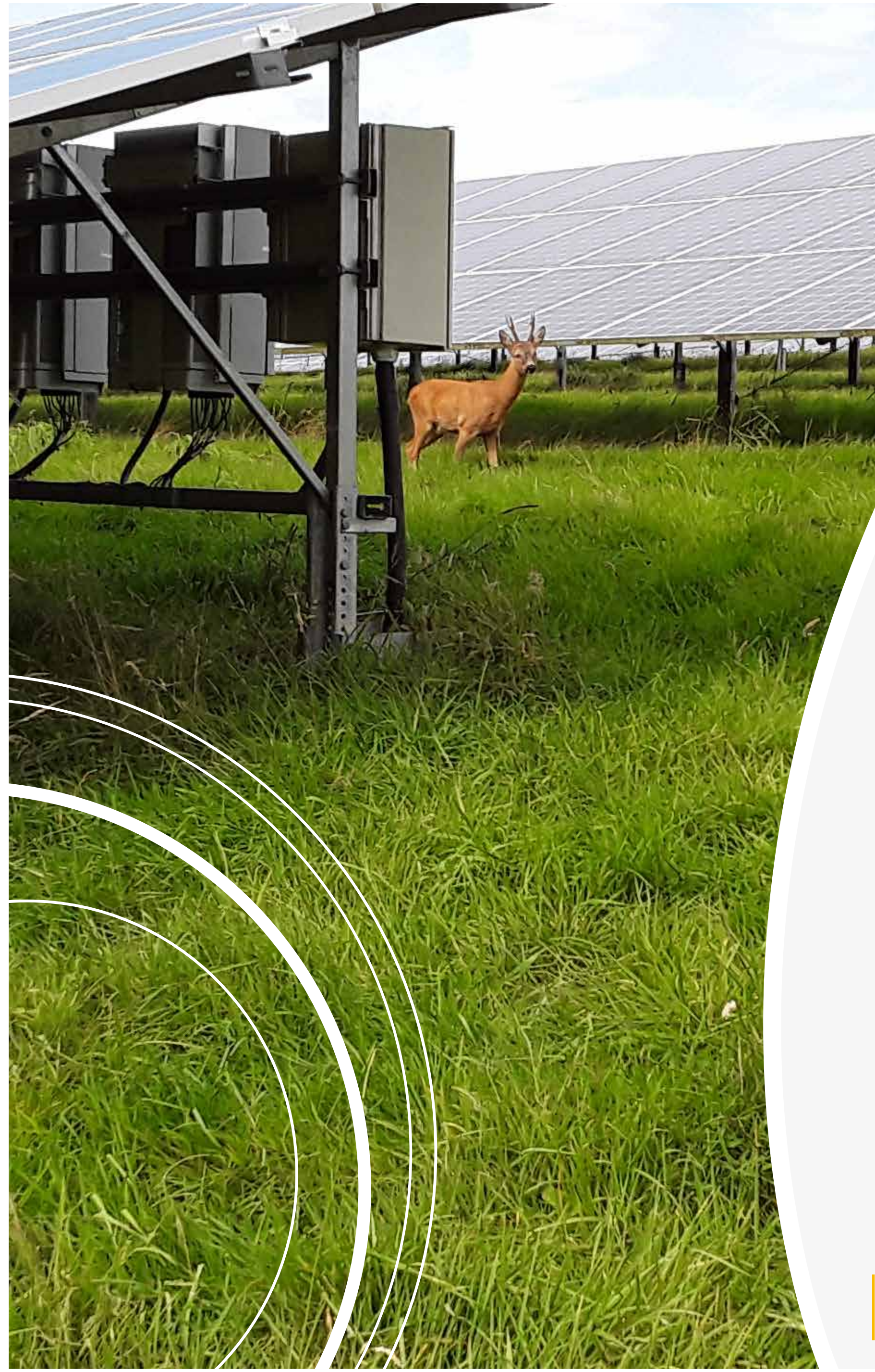


A hibernacula constructed within the field margin of a solar farm

While the uptake rate of bat boxes seems low, it is important to note that bat boxes which are confirmed to be used by roosting bats in any one year are considered successful. This is particularly due to the short lifespan of evidence of use (droppings) and the use of multiple roosts by bats. Since our monitoring work began we have found bat boxes have an average occupancy rate of 15% and of all 24 sites where we have monitored bat boxes 46% of them have at least one bat box in use. Given that during the construction of the arrays no losses of bat roosting sites occurred, the installed enhancement measures have been demonstrated to deliver a real gain in biodiversity.

Where we hold the information on the installation dates of the boxes, the success rate (percentage of boxes internally inspected found to be used by target species) of bat and bird boxes can be calculated. Currently we see no particular trend in the percentage of boxes used within a particular site. There does appear to be a small, non-significant increase in uptake over time but currently the data set held is inadequate to draw any meaningful trends.

Habitat enhancements on solar sites extend well beyond bird and bat boxes and include an array of measures such as hedgerow planting, log pile installation and hibernacula creation. The success or otherwise of these features is difficult to measure quantitatively, however they provide valuable features within a landscape.



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Mammals

We recorded eight different mammal species using the sites (including bats found in boxes). Species included roe deer as well as badger, brown hare, rabbit, fox, mole, and field vole.

Rabbits were the most commonly observed mammal in 2019, recorded on 40% of sites, while hares (recorded on 53% of the 2018 sites) were recorded on 32% of the 2019 sites. Evidence of foxes was recorded on 28% of sites, and 16% of sites were being actively used by badgers with evidence of foraging being found. New setts have also been recorded at the margins or solar farms which might be indicative of the high quality of foraging opportunities within the array. We intend to examine how many of the sites were known to be used by these species prior to construction of the solar farm.

Despite the 6ft deer proof fencing, roe deer were sighted within 12% of the sites, as shown in the adjacent photograph. All solar farms found to be used by deer are grazed by sheep.

Common species such as field voles (8% of sites) and moles (4% of sites) encountered during the 2019 monitoring, were only recorded on the odd occasion which does not necessarily indicate an absence from the sites, but rather under-recording of these less visible species. Given the abundance of barn owl nests recorded in nest boxes it seems reasonable to assume that vole numbers (a primary food for barn owls) are high in solar farms.

A roe deer spotted within a solar farm

The high numbers of brown hare recorded for a second year in a row is interesting as this is a species which has suffered recent declines and is a Species of Principal Importance under the NERC Act 2006. We believe that solar farms offer an important habitat where this species can forage and shelter with little disturbance or persecution. Where this species was recorded within sites, it was present in fairly high numbers and was seen to be sheltering beneath the panel structures.

The mosaic of relatively undisturbed habitats within a solar farm can be particularly valuable for a range of species

Invertebrates

We recorded 75 ad-hoc observations of different invertebrate species across the sites monitored in 2019, with 28 species of butterflies; 4 moths; 11 beetles; 8 dragon/damselflies; 7 bees; 3 grasshoppers and crickets; as well as 14 other species.

We conducted two detailed surveys, recording butterflies and bumblebees on a total of 7 transects within one site and four separate visits to survey for butterflies on another site. For the remainder of the sites, invertebrate information was obtained through ad-hoc observations noted by surveyors as they were undertaking the walkover survey. As such, the invertebrate data is affected by the same limitations as the bird data. Large numbers of invertebrates were likely under-recorded, with only the most visible and easily identifiable species recorded.

As with the 2018 findings, almost half of the invertebrates recorded (49%) were butterflies. Butterflies were recorded on 95% of the sites we surveyed in summer 2019 with an average of 4 butterfly species per site.

Buff tailed bumblebee on red clover
Banded demoiselle on red clover within a solar farm

Meadow brown was the most commonly recorded invertebrate, found on 71% of sites we surveyed. Similarly, easily distinguishable and common bumblebee species were commonly recorded; red-tailed bumblebee on 46% of sites and buff-tailed bumblebees on 33% vvof sites.

Of the 28 different butterfly species recorded, small heath, grayling and dingy skipper are 'High' Butterfly Conservation Trust priority species and Species of Principal Importance under the NERC Act 2006, each of which were recorded on single sites.

Sites with higher botanical diversity (recorded during botanical surveys) seemed to have higher recorded diversities of invertebrates (from the ad-hoc recordings only). Statistical analysis indicates that there is no significant correlation at present within our data. Butterfly diversity shows a similar non-significant correlation with botanical diversity as can be seen from the scatter graph below. The variable approach taken to invertebrate recording makes drawing comparisons from different sites difficult. To enable accurate comparisons to be drawn, a standardised survey methodology for each site would be required with each solar farm being subject to survey on several occasions over a season. We are looking out for opportunities to begin this sort of study as invertebrate diversity is an excellent indicator of ecosystem health and biodiversity.

Case Study: **Invertebrates**

Kencot Solar Farm – Foresight Solar Fund Ltd

Kencot Solar is a 48ha (37MW) solar farm; due to the size and complexities of the site we undertake 30 botanical quadrats (split between the northern and southern parcels) as well as detailed butterfly surveys. The 2019 monitoring survey recorded differences between the north and south despite comparable management, with 38 different flowering species and 10 different grass species in the northern parcel (which is the exact same number as found in the 2018 survey) compared to 7 different grasses and 36 other species in the southern, with slightly higher occurrences of injurious weeds in the southern parcel. This helps to inform future management works and ensure the best result for biodiversity within the site. This highly diverse site is where the Butterfly Conservation Trust 'High' priority dingy skipper and small heath were recorded. Both species have been regularly recorded on this site throughout, from the initial pre-construction surveys to the annual monitoring. The monitoring shows a steady increase in invertebrate diversity over time with 22 species in 2018, 15 in 2017 and 10 in 2016.

SOLARVIEW

Conclusion

The compilation of the dataset outlined within this report is the result of multiple companies appointing us to conduct ecological monitoring of solar farms throughout the country. This remains a unique study and to the best of our knowledge there remain few other studies which have aimed to aggregate data from ecological monitoring of solar arrays with the aim of presenting an overview of the ecological performance of these sites.

In this report we are able to provide a valuable summary of our initial findings, which helps to underpin the way we (and the industry as a whole) conduct pre-planning surveys and prepare management plans going forwards. The industry needs an evidence base to ensure that ecological impact assessments are accurate and the opportunities for ecological enhancement are maximised.

We are currently collaborating with Wychwood Biodiversity as well as Lancaster and York Universities to collate the information we (Wychwood Biodiversity and Clarkson & Woods) have, as well as carrying out a range of multivariate statistical analysis into the effects of various extraneous variables on solar farm biodiversity and the ecosystem services solar farms can provide. This will be submitted to a peer reviewed journal this coming year.

We will continue working with academic institutions so that further detailed statistical analysis examining how different solar farms can maximise their biodiversity potential. With the aim of monitoring ever more sites across the UK we hope to gather enough of a dataset that the results can be extrapolated to represent the scale of ecological enhancements delivered by the solar industry across the UK.

Additionally, we have had input into a tool being created by a group of academics, led by Lancaster University, known as SPIES (Solar Park Impacts on Ecosystem Services). This evidence based tool is aimed at helping solar park developers and operators make management choices which will benefit the environment and people (https://www.lancaster.ac.uk/spies/).

If you would like to know more about the monitoring surveys we conduct, or if you have a solar site which requires upcoming monitoring and would like your site to be included within our important study please feel free to get in touch.

Common blue butterfly within a Solar Farm

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