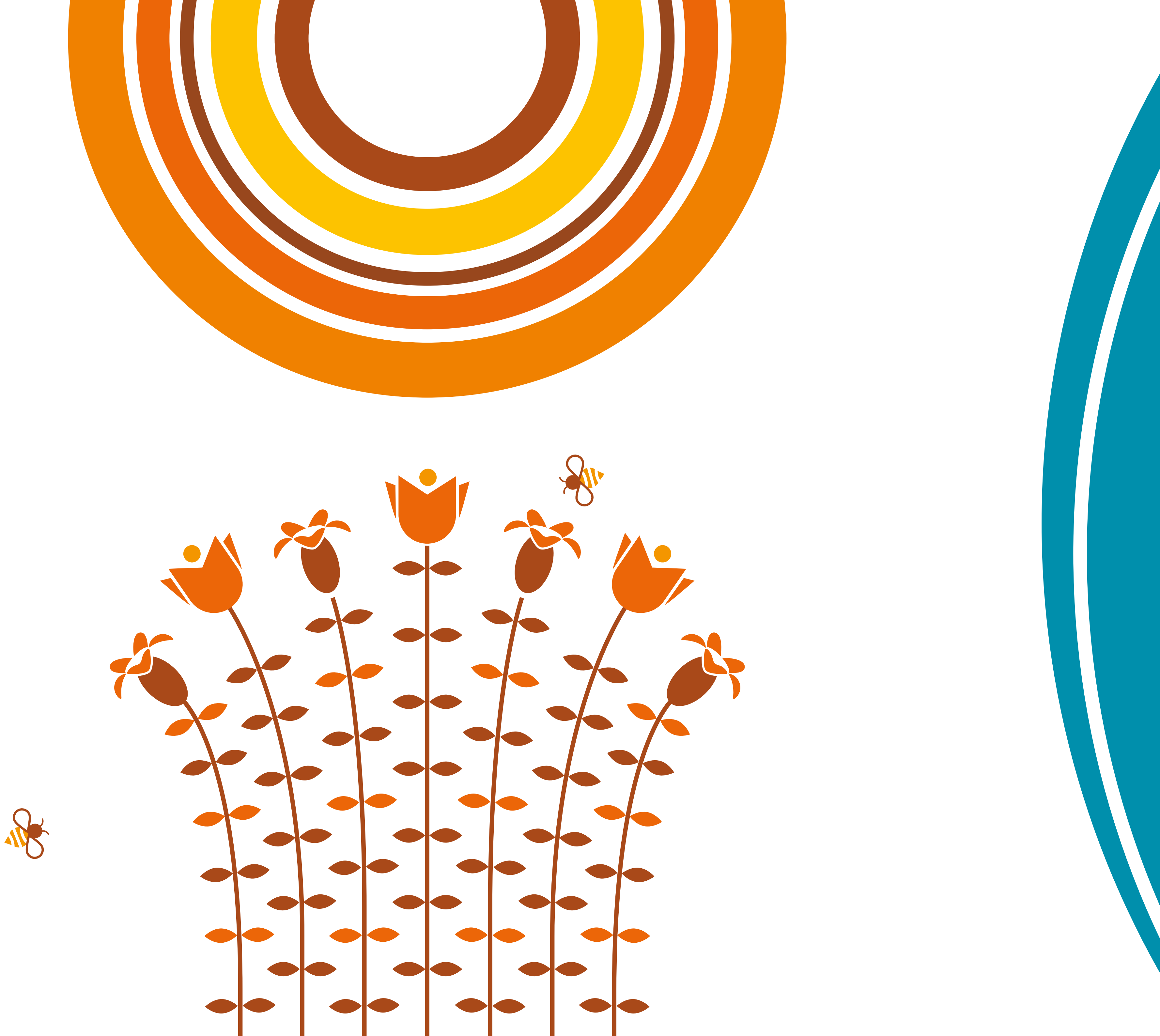
SOLARVIEW

ECOLOGICAL MONITORING
OF SOLAR SITES OVERVIEW
OF **2020** SURVEYS

CLARKSON & WOODS
ECOLOGICAL CONSULTANTS

Medium Consultancy of the Year CIEEM AWARDS 2019 WINNER



SOLARVIEW

Welcome to the 2020 'Solarview' report, an overview of all solar sites monitored by Clarkson & Woods in 2020. As the third overview report, we have also included some of the temporal changes we have seen in sites with long-term monitoring.

This annual report amalgamates the results of the ecological monitoring works Clarkson & Woods undertake on a large number of ground mounted solar PV sites across the country, examines trends in the data and provides general observations our ecologists have made through the year. Through producing these reports we hope to raise awareness of how solar farms and their management affect wildlife, and by doing so inform future impact assessments and management plans. We hope that this report will be of interest to operators, local authorities, ecologists, farmers and the solar trade industry alike.

While this report looks at trends, we share our dataset with Lancaster and York Universities to enable its use within scientific studies. To build on this in 2020 we collected soil samples from solar sites across the country, as part of a Lancaster University study looking at carbon cycling and storage across solar sites. This year we are taking a big step forward and working with Lancaster University and a variety of solar farm owners to begin undertaking a Natural Capital Audit of solar farms across the country.

As with every year, the main limitation of this study is that the sites we monitor represent only a proportion of those that exist within the UK. The sites that we monitor tend to be a portion of those which have an ecological management plan in place and so are more likely to have ecologically driven management, though there are some notable exceptions to this, where the owners or asset managers have actively sought ecological monitoring or wildlife condition assessments on sites they are involved with. These asset managers and owners who arrange for monitoring beyond the requirements remain the exception, and some of the more established sites are less likely to have this requirement. As such whilst this report can be used to extrapolate on the performance of solar arrays in general across the UK some caution should be drawn in that the study may not be fully reflective of the UKs solar farm portfolio.

All data and photographs used within the report have been gathered during ecological monitoring of solar farms by Clarkson & 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 Hannah Montag.

Clarkson & Woods have been undertaking ecological monitoring of large scale ground mounted photovoltaic solar farms (for the purposes of this report, this includes all sites above 3MW) since 2014, monitoring over 100 solar sites to date. In this time we have monitored only one site smaller than 3MW (a coastal 1.8MW site) with sites ranging up to 49.9MW. The majority of the sites we monitor remain fairly small, with only 7 sites over 20MW in size compared to 48% of sites being 5MW or less, 5MW sites are by far the most common size that we monitor (29% of the sites we monitor are 5MW in size).

Our portfolio of monitoring sites comprises approximately 10.5% of all large (over 3MW) UK solar farms*. In 2020 we monitored 3% of the GBs sites (33% of our portfolio) as at many sites monitoring is not required on an annual basis, but rather follow an intermittent schedule.

Having been monitoring solar farms for over 7 years we have developed a standardised botanical monitoring protocol which uses quadrat surveys within different areas of the solar farm; to provide a comparable dataset. We also conduct a general walkover survey, taking ad-hoc recordings of plants, invertebrates, birds, mammals and anything else of interest including bat, bird and dormouse boxes. We also undertake a variety of other surveys where sites have bespoke requirements.

In 2020 we went beyond this and where we had permission and it was safe to do so, we also collected soil samples from 10 solar sites for Lancaster University while undertaking our botanical monitoring. These soil samples are being used to look at carbon cycling and storage on solar farms.

62% of the sites we monitored in 2020 were monitored by us for the first time that year, despite this they are seemingly older than any we have surveyed before, with the youngest being operational for 3.5 years while one had been operational for nearly 8 years, and had never before been monitored. Having previously monitored 38% of the sites, we have been able to look at trends over time, particularly for botanical data where we take quadrats which allows for more comparable assessments.

Looking ahead to next year we are hoping to take more measurements and include additional targeted species surveys.

* Renewable energy planning database monthly extract – September 2020 https://www.gov.uk/government/publications/renewable-energy-planning-database-monthly-extract last updated 20th January 2021.

A well grazed array with solid access tracks to prevent poaching around gates of the quite wet site.

A wet margin, maintained for drainage, offering habitat for a range of species.

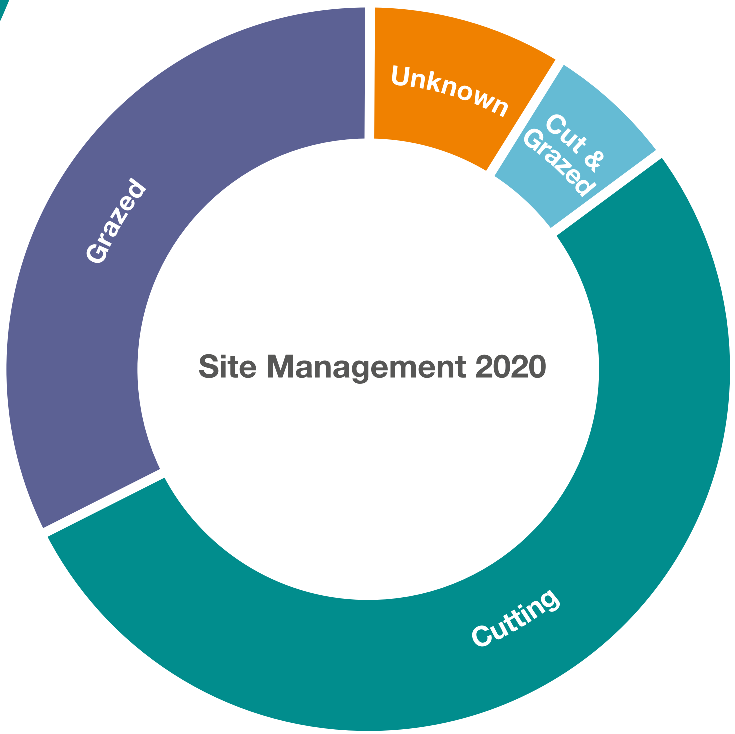
Grassland Management

From conservation grazed to intensively grazed, to completely unmanaged, to cut throughout every month to once every three years or with occasional shade / access strips, we have seen an array of management styles both across different solar farms and within individual sites. This extends to treatment of injurious weeds with some completely non-chemical treatments to other sites which are completely blanket sprayed with a glyphosate herbicide.

Over the years we have found that getting the initial management right both before and immediately following construction of the array is crucial for ease of long term management. This often contentious and occasionally costly task is key to maximising the solar farm's biodiversity potential. The initial seeding and management requirements vary depending on a range of factors from historic landuse, soil condition and structure, drainage, timing of the build, long term aims, and existing weed burden among other things, highlighting the importance of expert advice from the outset. If a site has a high abundance of injurious weeds prior to construction, weeds will likely continue to persist without heavy management. With enriched arable soils, the establishment of diverse wildflower meadows can take longer and often require higher levels of management in the first few years to lower nutrient levels.

This tends to be reflected in the management plans (where they exist) or strategies, with some detailing very prescriptive grazing or cutting regimes and some excluding management of the array entierly, a similar variation is seen in the requirements for monitoring. As with monitoring, the absence of specification within the management plans does not necessarily preclude monitoring, with some site owners or assesst managers undertaking additional monitoring to ensure they are aware of the conditions on site. In our view such precautionary or pre-emptive monitoring should be considered best practice.

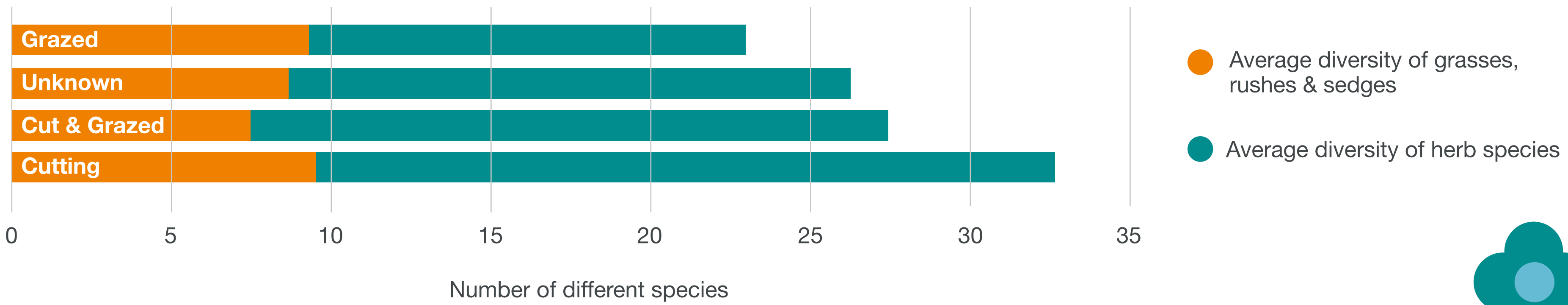
A well grazed rush pasture which provides valuable habitat, agricultural use and prevents shading of the array

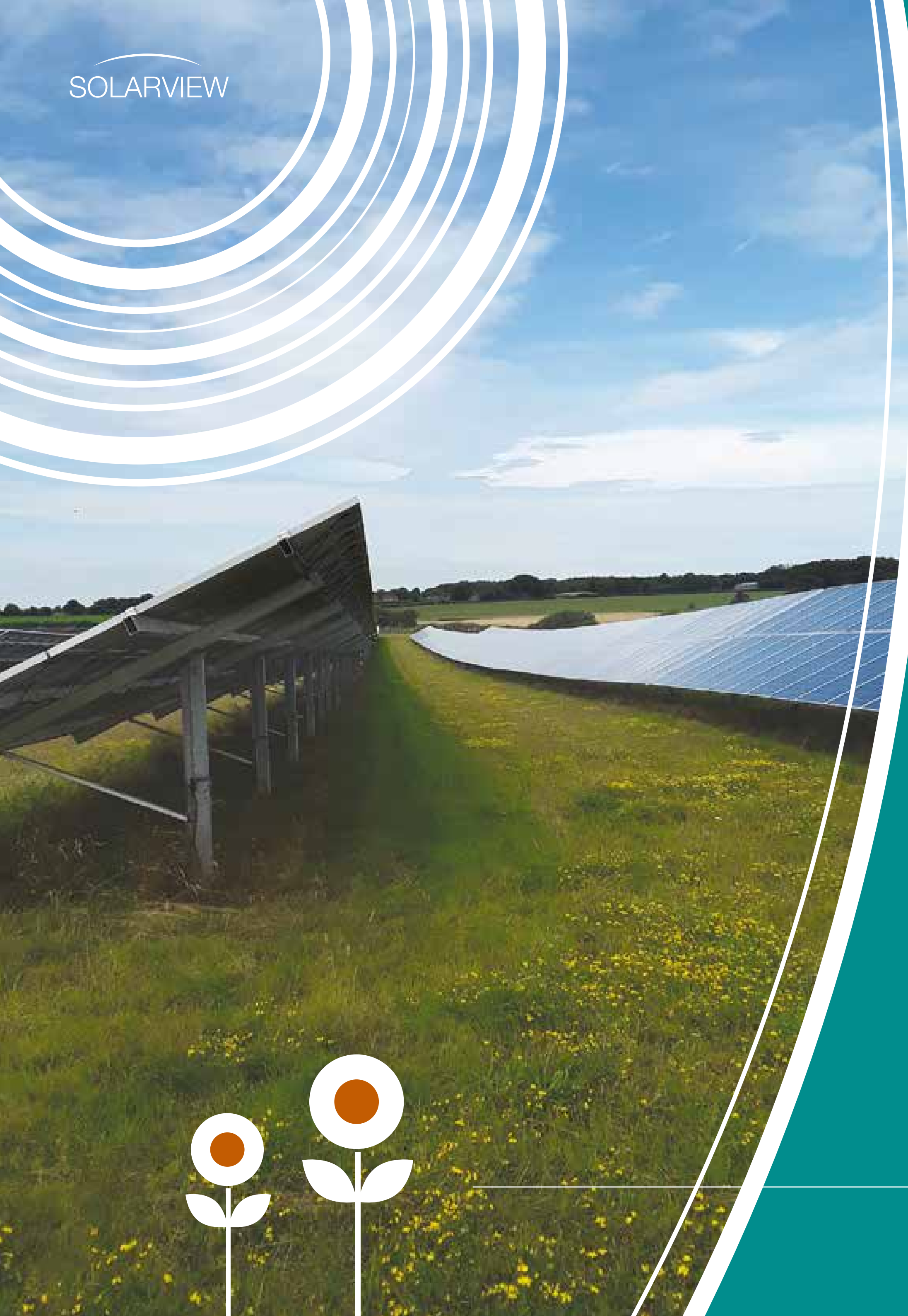


Overall, 38% of sites we monitored in 2020 are sheep grazed to some extent while 58% of sites are cut to some extent. We are aware of other grazing practices, such as the use of chickens, but we have yet to monitor any sites where the array interiors are managed in this way.

When looking at the bar chart of average species diversity by management type it appears that cutting is associated with a greater diversity, particularly of herb species. On average it would appear mixed management leads to lower levels of grass species the range for this between 7-8, whereas for cutting it is between 4-15, which is clearly a much bigger range. Given that 55% of the sites were managed solely through cutting, this practice having the largest range is unsurprising, however for total vascular plants the range was 13-54, with between 9-43 different herb species, the surveyed sites are clearly quite variable in terms of diversity. The lowest herb diversity was recorded on a grazed site, grazed sites had between 3-28 different herb species, however only three cut sites had higher herb diversity than the most diverse grazed site, one a former mica mine and two old airfields.

2020 - Average botanical diversity by management type





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 compromise between the desire to maximise biodiversity on the site and the need to ensure the efficient operation of the panels. A variety 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. Surveyors reported that this appeared to be a very popular approach in 2020. In 2021 we are intending to look more in more detail at how the shade cutting affects grassland diversity. There is some suggestion that as this further adds to the diversity of habitats it can be very valuable for invertebrates and reptiles in particular.

One of the more commonly encountered management challenges is management under the panels, with many obstacles in the way this can be quite a difficult area to get just right and different O&M contractors have different ways of achieving it. It is largely accepted that getting this area right in the first couple of years, with a dense grass dominated sward, is key to preventing problems with vigorous growth of nettles or injurious weeds.

The other most common management concern is collection of the arisings and what to do with them once collected. Given the low number of cuts taken a year and the inevitable high volume of cuttings, the removal of arisings and the sheer quantity of material can be difficult to handle. None of the sites we monitored in 2020 had arisings collected after cutting. This dead material in clumps can smother the vegetation

A site where cutting behind the panels and the shade cast by the panels has caused a reduction in flowers.

nutrients in concentrated patches. Several companies now mulch the clippings as fine as possible to prevent them swamping the regrowth. This still leads to a slow reduction in nutrients, however it is a much slower process. The comparison of soil fertility changes and subsequent floral diversity across sites is an area of research where we hope to conduct further studies in future years.

Management of solar farms, is not just about the array interior though, there are a whole host of valuable habitats which are often created as part of planning, from the field margins and bird nesting areas to new ponds and swales. This year in addition to the more obvious and measurable changes we are hoping to shine a spotlight on some of the additional habitats which have been provided by solar farms across the country!

In 2021 we are intending on paying greater attention to the management and diversity of field margins (between the boundary fence and surrounding hedgerows); these features tend to be managed differently to the array due to access constraints and so may increase the diversity of habitats across the solar farm. Where well managed these can be valuable features, particularly for maintaining landscape connectivity.

A herb rich, low growing grassland within the array provides opportunities for pollinators.

Botanical Diversity

We have measured 1,989 botanical quadrats within solar farms over the last five years, with over 500 in 2020. Our standardised approach to botanical surveys allows us to make comparisons both over time, across different quadrat locations and across sites.

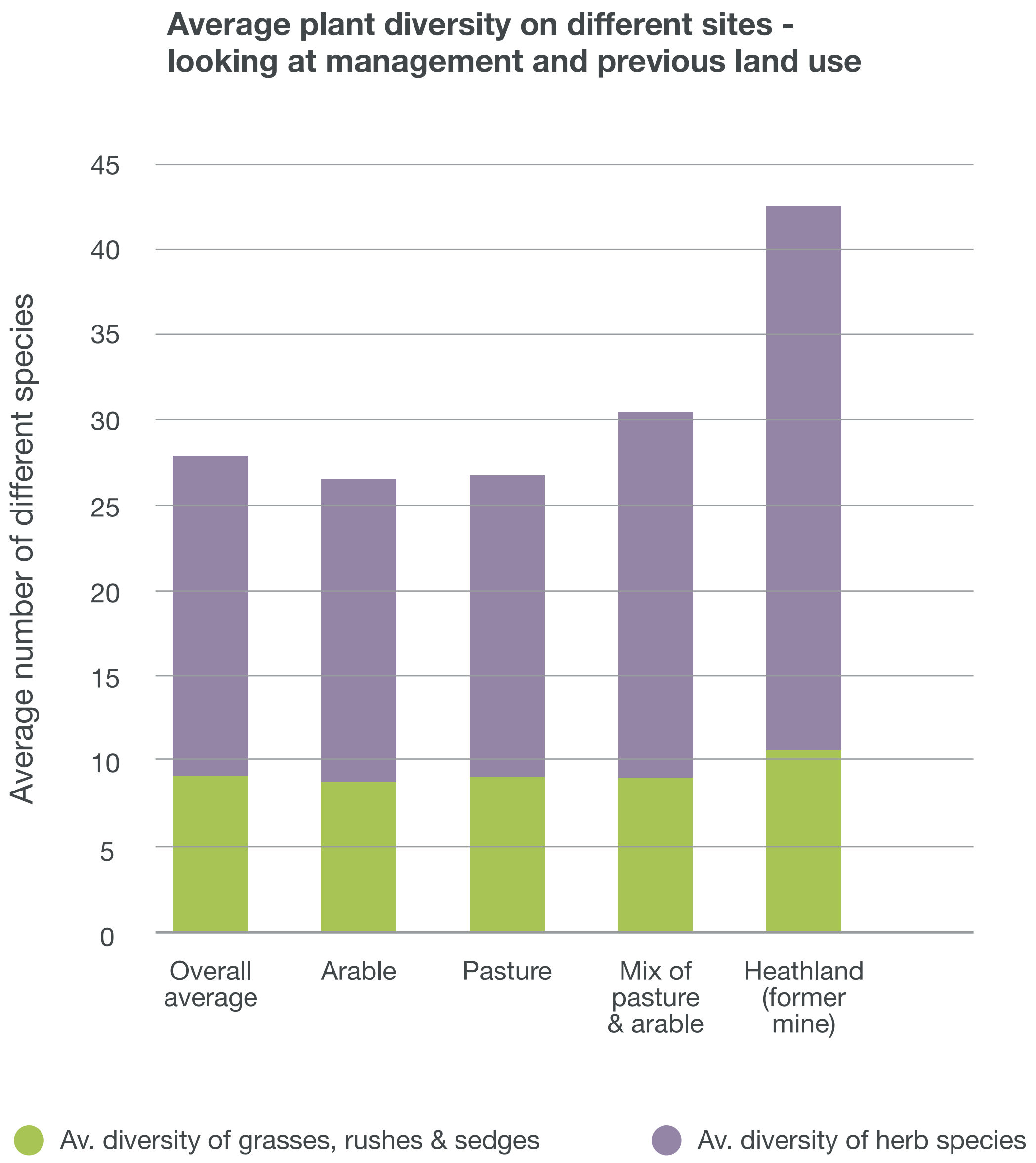
For the majority of sites we use a standardised methodology; taking five randomly selected 2m x 2m quadrats directly below panels (“beneath” quadrats), five between the strings of panels (“between” quadrats) and five between the edge of the solar farm and the bounding security fence (“exterior” quadrats) which allows us to look at differences across the site. At some sites we take additional quadrats, for instance where there is an important habitat within the exterior (a bird nesting area, a marshy grassland or peat bog etc) and we are hoping to include field margins within our standardised approach this year as we think that these features are often overlooked. Very occasionally, particularly for larger sites where there has been a mixed approach to seeding or prior land-use we undertake twice the number of quadrats. If you have a site with particularly interesting habitats you would like to include additional monitoring of, please get in touch.

A diverse grassland sward at the edge of an array.

2020 included monitoring of some very unique sites; from peat bogs to former mica mines and airfields as well as the usual arable fields and pasture. In total, over 208 different vascular plants were recorded including 46 different graminoids (grasses, sedges and rushes) and 162 different broad-leaved plants. This included a variety of charismatic species such as eyebright, pyramidal orchid, hare's foot clover, wood sage, red campion, wood avens and foxglove. Some of these charismatic species had been included in seed mixes, while others had self-seeded from the adjacent habitat.

Despite the variety of different species, we record a similar average species diversity per site each year, with an average of 28 different species recorded on each site in 2020 compared to 27 species per site in 2019 and an average of 25 species per site in 2018. This could indicate a slight overall increase in diversity across time, though we haven't accounted for the age of the arrays in this analysis. It is an interesting trend which, if sustained, could result in a doubling of average species diversity over the 25-35 year life time of arrays.

The average floristic diversity is affected by management and previous land use, as shown in the clustered column graph overleaf. The number of different herb species in particular appears higher on cut sites, and lowest on sites where no management information was available. Grass diversity was much more static regardless of management type, ranging from 7.5 species on average on sites which are both cut and grazed to 9.5 species on sites which are just cut. Grass diversity ranged similarly based on historic land use, with former mine works (heathland) sites being the most diverse, both in terms of grasses (with an average of 10.5 different species) and overall diversity (with an average of 43 different species). Though there was no real difference in the average diversity of formerly arable or formerly pasture sites.

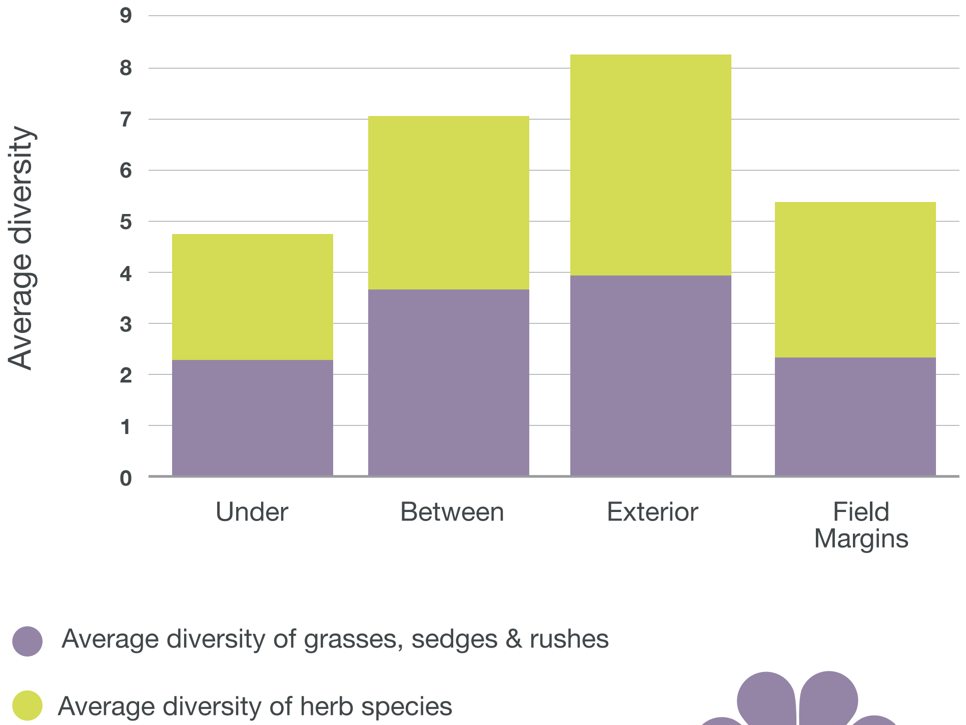

Average plant diversity on different sites -
looking at management and previous land use
Average number of different species
45
40
35
30
25
20
15
10
5
0
Overall average
Arable
Pasture
Mix of pasture & arable
Heathland (former mine)
Av. diversity of grasses, rushes & sedges
Av. diversity of herb species

TOP 10 SPECIES BY LOCATION (grasses shown in green)

Overall	Under the panels	Between the strings	Array exterior
Yorkshire fog	Yorkshire fog	Yorkshire fog	Yorkshire fog
Perennial rye-grass	Creeping bent	Perennial rye-grass	Perennial rye-grass
Cocksfoot	Common nettle	Creeping bent	Cocksfoot
Creeping bent	Cocksfoot	Red fescue	Red fescue
Red fescue	Red fescue	Cocksfoot	Creeping bent
White clover	Perennial rye-grass	White clover	White clover
Creeping thistle	Common bent	Broad-Leaved Dock	Creeping buttercup
Common bent	Dandelion	Dandelion	Crested Dog's-tail
Dandelion	Creeping thistle	Crested Dog's-tail	Common bent
Common nettle	False oat grass	Creeping buttercup	Creeping thistle

Yorkshire fog remains the most common plant across all the quadrat types, recorded in 62% of all quadrats taken in 2020; a readily establishing species which is present across a variety of habitats and able to establish in a range of conditions, this grass does however grow to 1m tall and so may need additional management to prevent shading of panels, including shade cutting. After Yorkshire fog the next most common grass is perennial rye-grass which was recorded in 37% of quadrats, with only 16% of the quadrats below panels featuring perennial rye-grass compared to 52% of the same quadrats containing Yorkshire fog. The most common herb species was white clover, recorded in 24% of quadrats, but only 6.2% of the below panel quadrats. As can be seen from the table, the species diversity, particularly for grasses, was broadly similar throughout the quadrats, with cocksfoot, creeping bent, perennial rye-grass, red fescue and Yorkshire fog being in the top 10 for every quadrat type!

Stacked column showing the average diversity across quadrat types

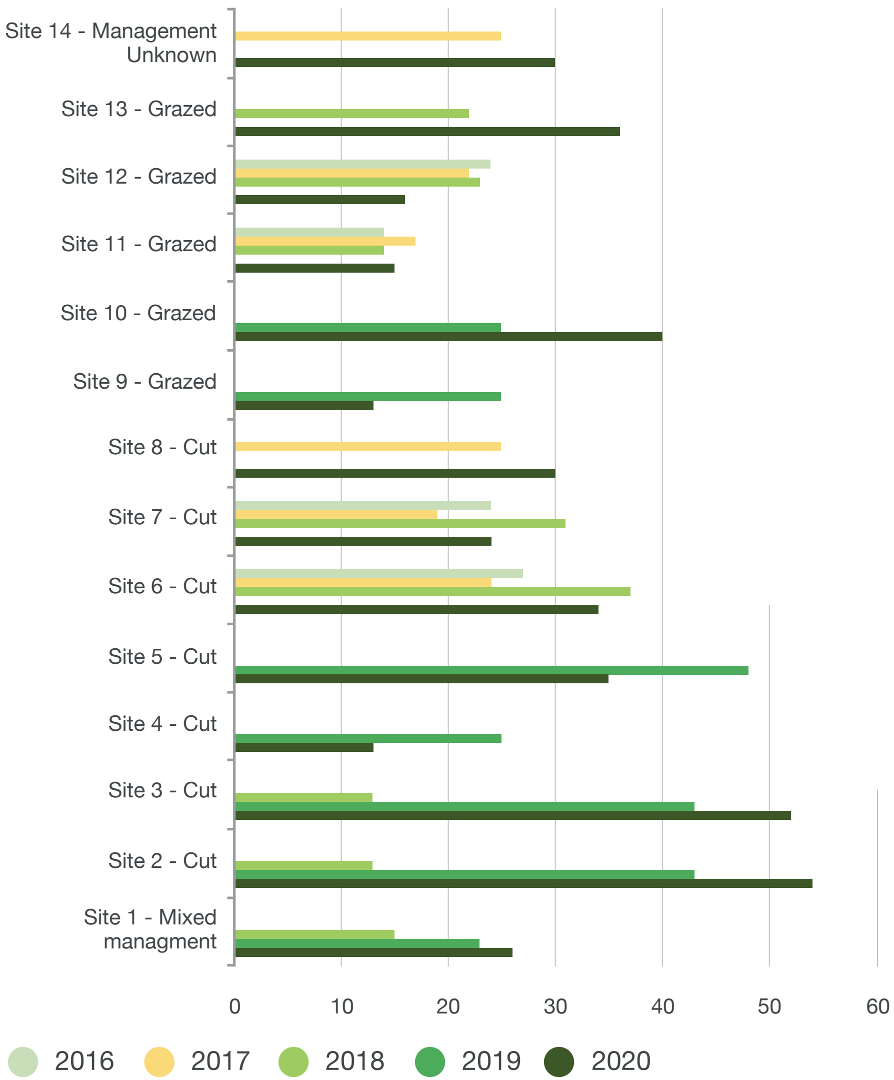


Looking at the average diversity on a quadrat location basis, it remains that the array exterior (between the solar panels and the boundary fence) is the most diverse. With an average of 8.2 different species per quadrat, compared to 5.3 different species per quadrat in the field margins, 7.1 between panels and 4.7 different species per quadrat taken under the panels.

In 2020 we recorded bare ground in 35% of all quadrats but only eight quadrats (less than 2%) were completely bare; this is substantially lower than in 2019 where 50% of quadrats contained bare ground and 3% were completely bare. These eight quadrats were across four different sites, with five taken directly under panels, one within the field margin and two taken between the panels. At least two of the under panel instances reflect recent glyphosphate spraying to prevent vegetation growth below the panels.

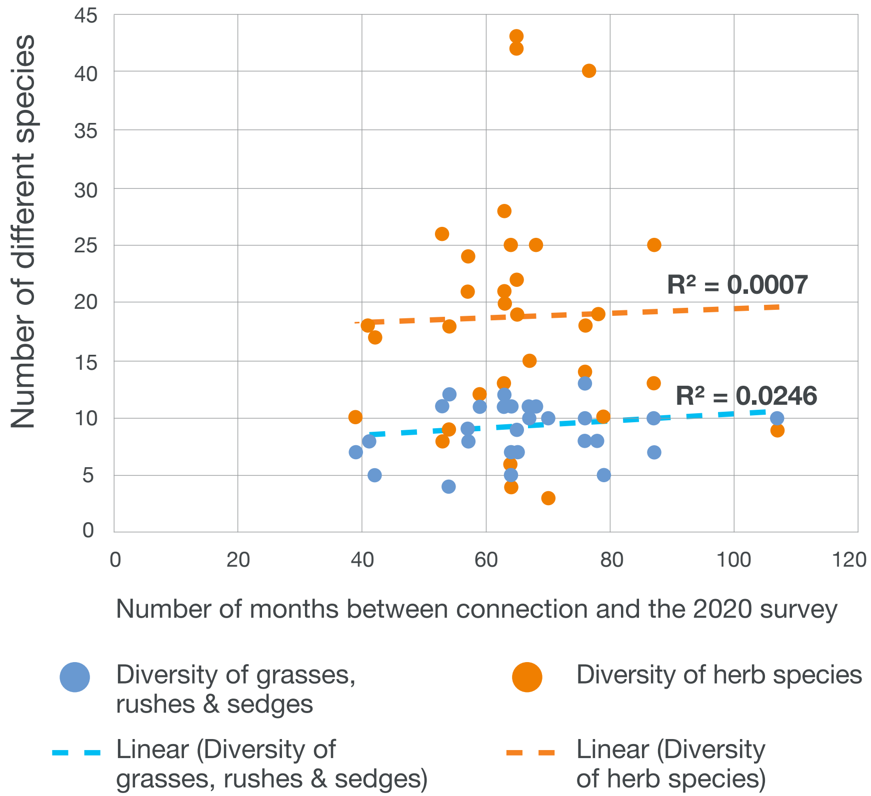
We have long anticipated that with appropriate management solar farms would diversify over time, as the nutrients decrease and the more nutrient demanding species die back. This is illustrated in the adjacent clustered bar graph for sites which have now been monitored over a five year period. As can be seen from the graph, for half the sites shown (Sites 1, 2, 3, 8, 10, 13 and 14) we are seeing clear botanical diversification over time. However this is not always observed, with a loss in diversity being recorded at three sites, although examination of the data suggests this reflects the use of herbicides to control nettle growth on at least one of the sites. The reason for the decline in diversity is however not clear at all sites.

Floristic diversity across different years surveyed



Given the age of some of the arrays we monitored in 2020 we had anticipated the results would include greater floristic diversity overall. However looking at the scatter graph below, there is no relationship between age of site and botanical diversity. Reasons for this lack of relationship may be due to the variability of seeding requirements, particularly of older arrays, or the use of herbicide.

Botanical diversity compared to age of the array



Case Study:

Kernick Dam & Trethosa – Bluefield Solar Income Fund

As a former mica quarry, this site has been restored and enhanced with areas of acid/neutral grassland, heathland, marshy grassland and patches of scrub since its construction in 2015. We were quite excited to monitor this site. Managed through cutting, this 24ha solar farm comprised two very different areas; one very botanically diverse with 40 different herb species recorded and the other way above average with 24 different herb species. Species present included yellow rattle, wood sage, lesser spearwort, selfheal, pearlwort, ling heather, heath speedwell, greater birdsfoot trefoil, eyebright and broom; most of which were not recorded on any other sites during the 2020 surveys.

Interestingly, the Kernick Dam portion of the solar farm was consistently diverse with an average of 14.6-15 different species per quadrat found in each different quadrat location, ranging from 13-18 different vascular plants per quadrat.

The broom and gorse scrub on site is well established, which provides valuable habitat but can also infringe upon management of the site. This has led to changes in the management strategy with grazing being introduced in the spring to lower the sward height and reduce the need for cutting.

This site is clearly quite different from the standard solar farm in terms of historic land use and existing habitat type, which has required targeted management and careful adherence to the existing management plan to maintain. However the two distinctly different areas and variety of habitats they continue to provide, highlights the potential for solar farms to maintain these valuable habitats.

There can be significant differences in habitats between and under the array (or in this case, under the frame).

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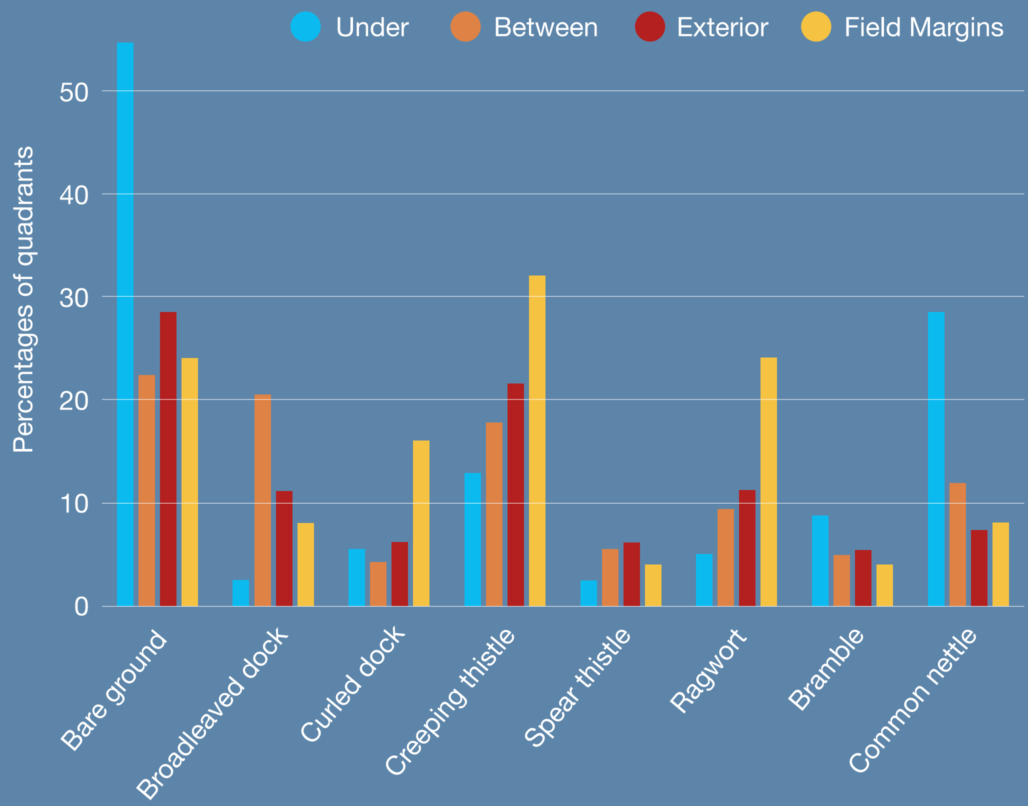
Weeds and Undesirable Species

Injurious weeds continue to be a bone of contention on solar farms, though they often provide valuable food sources for invertebrates. Under the Injurious Weeds Act, 1959, broadleaved dock, curled dock, creeping thistle, spear thistle and ragwort legally require management to prevent spread onto adjacent land, and this management can be costly.

While we undertake ecological monitoring, principally to assess how sites are establishing and adherence to the agreed management plans, we also look at various management considerations raised by O&M companies and landowners, from extent of bare ground to nettles growing into DNOs or injurious weeds spreading onto adjacent land.



As with the previous Solarviews, the percentage cover of injurious weeds within solar arrays typically remains relatively low and is likely to be consistent with those levels recorded in local habitats.

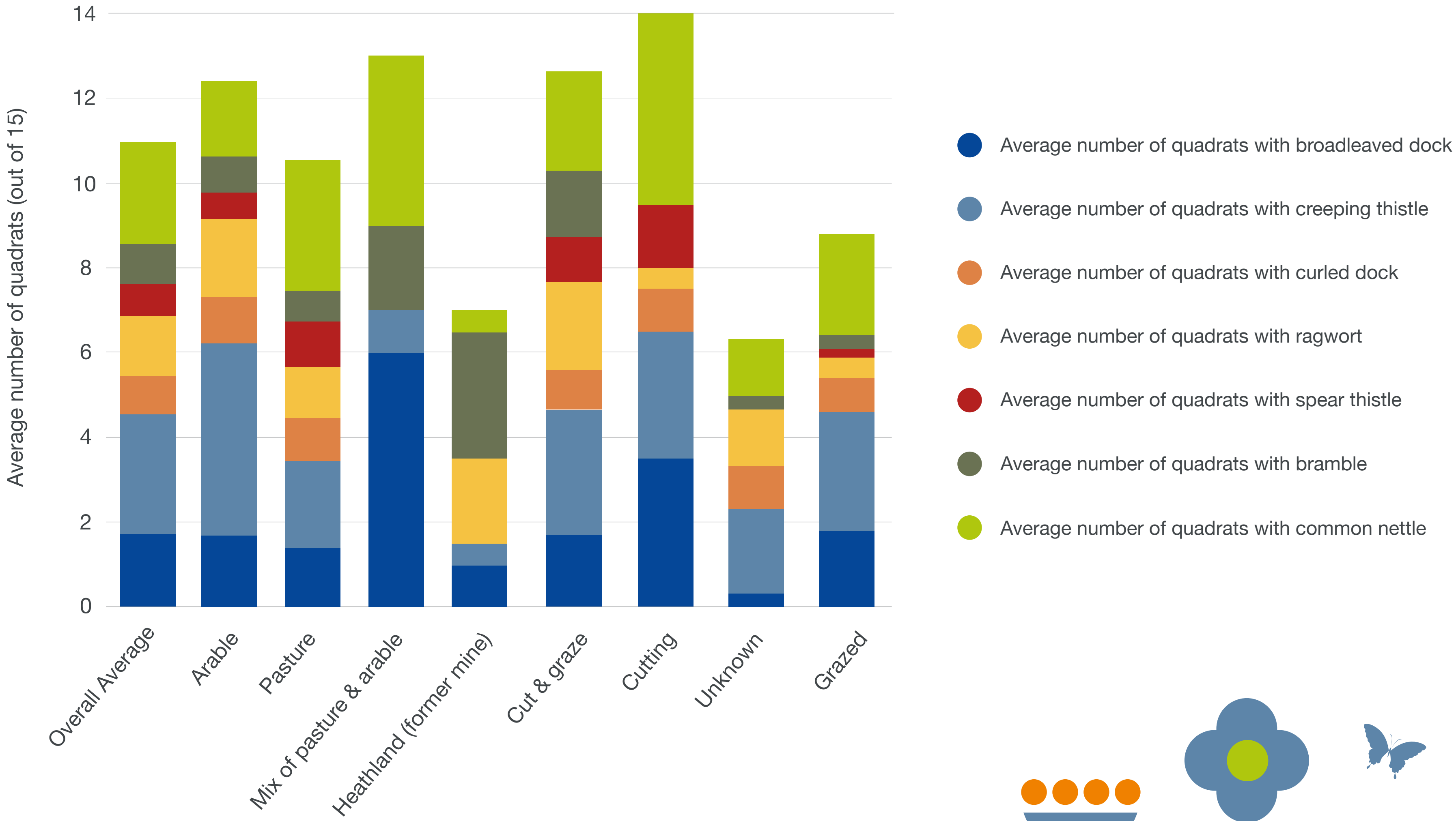
A below panel photo showing nettles and some bare ground amongst establishing grasses.

As is clear within the bar graph on the previous page, creeping thistle remains the most common and consistently encountered injurious weed across all but the between quadrats, where broad-leaved dock is the most common. Common nettles are by far more common below the arrays as is bramble; these are often associated with management concerns as they can grow tall, and spread into DNO boxes and between panels, as well as obstructing access for maintenance and management. We had always anticipated that with appropriate management, the abundance of these species would reduce over time, both due to the establishment of the grasses subsequent to reducing the extent of bare ground and the reduction in nutrient levels. However, when looking at the statistics there is no clear relationship between age of the site and the number of quadrats which contain either bramble or nettle. This may in part be due to the variable management of these species/the below panel areas, or indeed the persistence of these species.

We are keen to know how different companies manage these species and the long term effectiveness of these solutions. In 2021, we hope to take a more targeted look at these species (and any other species of concern), looking at how management affects their abundance. A very superficial look at pre-construction habitats and management compared to abundance of weeds (based on number of quadrats in which they occur) is shown in the adjacent stacked bar graph. The graph shows that sites managed through both cutting and grazing tend to have higher occurrences of weeds; creeping thistle tends to be more associated with former arable sites while broad-leaved dock is more associated with mixed sites (which were once both arable and pasture) and former pasture sites have more occurrences of nettles.

A diverse sward of varying heights in the array exterior.
Panels positioned sufficiently high so as not to be shaded

Stacked bar graph showing average abundance of different species compared to different site conditions



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Birds on Solar Farms

We recorded 65 different bird species during our monitoring in both 2020 and 2019. Species recorded in 2020 but not 2019 included curlew, grey partridge, mistle thrush, and snipe among others. Of the bird species recorded in 2021, 12 were British Trust For Ornithology (BTO) Red listed Species of Conservation Concern and another 12 were BTO Amber Listed.

The recorded species assemblage, shown in the bar chart overleaf, was largely typical of farmland habitats with the exception of some water birds such as coot and moorhen.

Overall, an average of 11.75 different bird species were recorded on each site; this is slightly lower than the 12.5 different species per survey found in 2019. As with all other elements of this report, this data was highly variable, with some sites having as many as 33 different bird species whilst others had as few as 4. 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, including timing and weather during the survey. While we push to undertake as many of the surveys as possible during peak survey season (May-July) and during bouts of clear, calm weather when bird activity is highest, sometimes surveys are commissioned outside of this window. Nevertheless we believe that the data is useful to examine general trends and highlights continued use of sites by birds of all kinds. Species such as curlew, skylark and meadow pipit, are all species of conservation concern which get considered during planning applications, with various mitigation and compensatory measures proposed for these species. Without detailed surveys it is difficult to confirm the extent of the impacts and success of mitigation, which requires further more detailed survey, but in the interim, continued occurrence of these species within solar monitoring is encouraging.

Over the last three years of solar monitoring we have recorded 105 different bird species; including 22 Red Listed Species of Conservation Concern and 20 Amber Listed Species of Conservation Concern. As with the previous findings, the numbers of Red and Amber listed birds recorded across sites in 2020 was highly variable, with some solar farms supporting as many as 10 Red listed and 5 Amber listed species, whilst on other sites no species of conservation concern were recorded despite surveys being undertaken during calm, dry days in June.

The bar chart shows that a large diversity of birds were recorded during the 2020 monitoring surveys. Wood pigeons were by far the most commonly recorded species in 2020 (and the third most common in 2019) recorded on 72% of sites (and 69% in 2019); as the UK's most common pigeon their abundance is not unexpected. Unlike the 2019 surveys, dunnock were the most commonly recorded Bird of Conservation Concern, recorded on 34.38% of sites, while in 2019 and 2018 skylark was the most commonly recorded species, which was recorded on 31.25% of the sites in 2020 but 50% of the sites in 2019.

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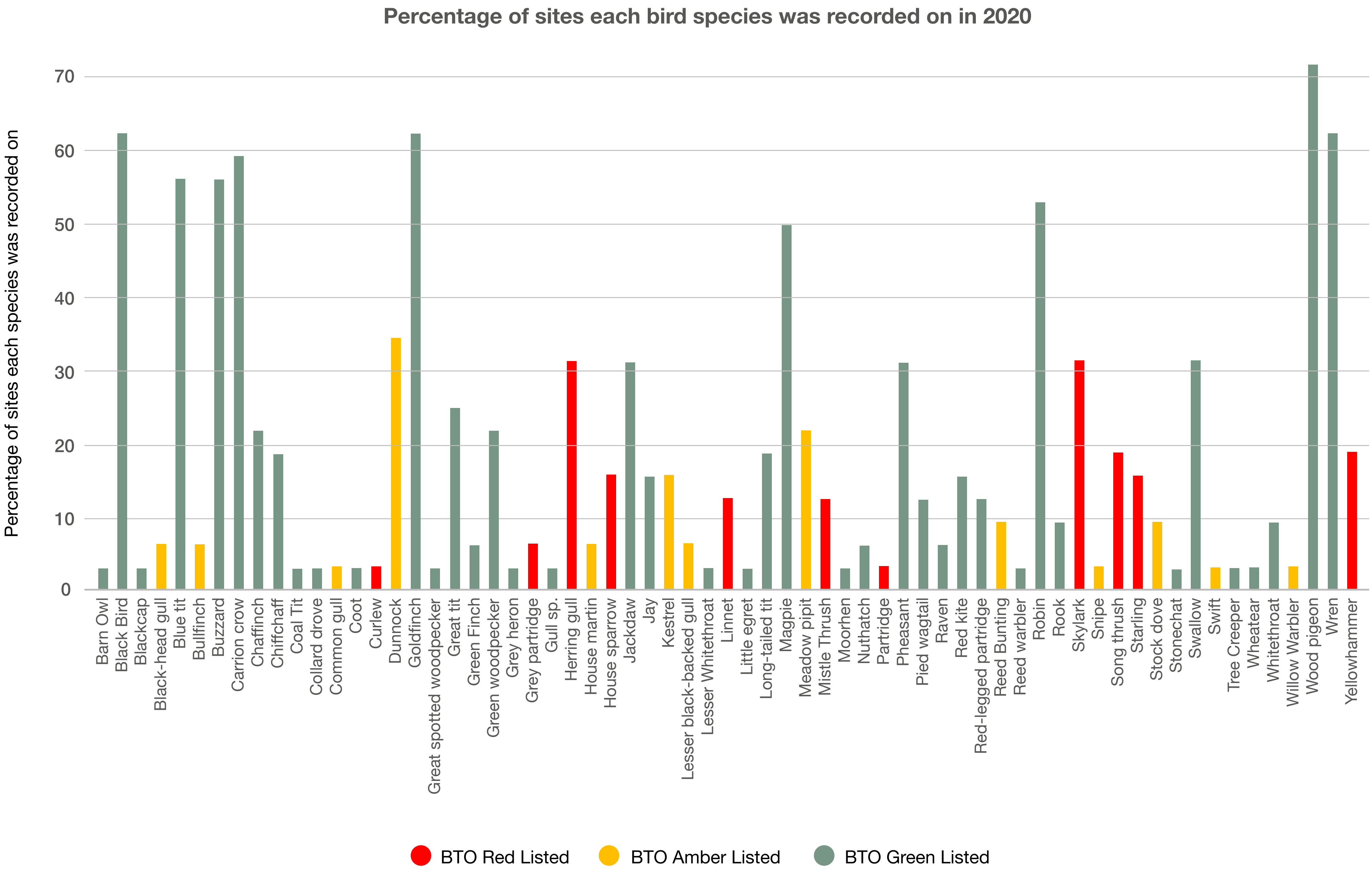
A grass rich sward enhanced to provide food for wild birds

Despite breeding bird surveys being undertaken on three sites, no ground nesting bird nests were found (a wren nest was found directly below a solar panel). However, ground nesting birds including skylarks and lapwings were flushed from sites by surveyors walking between the panels, and were noted singing while perched on the panels and foraging with the solar farm. Ground nesting birds typically require long sight-lines, therefore it has long been assumed that they would be displaced through construction of a solar farm. However, our monitoring indicates that skylarks and lapwing do use solar farms as part of their territory and may use sites for breeding, although as yet there is no data available on the effect of arrays on the reproductive success of ground nesting birds within arrays. It remains unclear whether continued use of arrays reflects site fidelity (the desire to continue to nest in the same location each year) or is evidence that the impacts of arrays on ground nesting birds are not as significant as feared. The longer we find ground nesting birds using operational arrays, the less likely that the use is reflective of site fidelity. This remains an important area where further research is required which we are currently looking for partners to pursue.

The 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.


Percentage of sites each bird species was recorded on in 2020
Percentage of sites each species was recorded on
0
10
20
30
40
50
60
70
Barn Owl
Black Bird
Blackcap
Black-head gull
Blue tit
Bullfinch
Buzzard
Carrion crow
Chaffinch
Chiffchaff
Coal Tit
Collard drove
Common gull
Coot
Curlew
Dunnock
Goldfinch
Great spotted woodpecker
Great tit
Green Finch
Green woodpecker
Grey heron
Grey partridge
Gull sp.
Herring gull
House martin
House sparrow
Jackdaw
Jay
Kestrel
Lesser black-backed gull
Lesser Whitethroat
Linnet
Little egret
Long-tailed tit
Magpie
Meadow pipit
Mistle Thrush
Moorhen
Nuthatch
Partridge
Pheasant
Pied wagtail
Raven
Red kite
Red-legged partridge
Reed Bunting
Reed warbler
Robin
Rook
Skylark
Snipe
Song thrush
Starling
Stock dove
Stonechat
Swallow
Swift
Tree Creeper
Wheatear
Whitethroat
Willow Warbler
Wood pigeon
Wren
Yellowhammer
BTO Red Listed
BTO Amber Listed
BTO Green Listed

Case Study:

West Raynham – Bluefield Group

Constructed in 2015, the 49MW site was seeded with a grazing mix and a wildflower rich margin which was initially managed through cutting but has recently moved towards sheep grazing with stock proof fencing to protect the seeded wildflowers from grazing during the flowering season. Some additional grass cutting had taken place prior to the survey. The wider site is separated into different segments to be grazed at different times of the year which maintains some areas of long sward throughout the year. This former airfield was known to be used by nesting skylarks, therefore, West Raynham was always going to an interesting site for bird life.

Three breeding bird surveys were undertaken in 2020 and 33 different species were recorded! This was the only site in 2020 found to be used by 10 different BTO red listed species; curlew, grey partridge, song thrush, house sparrow, mistle thrush, herring gull, linnet, starling, yellowhammer and of course skylarks.

While the other species recorded on site were more common (four were on the BTO amber list) and typical of farmland habitats, they were no less indicative of the good quality habitats provided on and around the solar farm. For instance, the margins were managed in a variety of ways and some had large tussocks providing optimal habitat for small mammals. These in turn provide a food source for predatory birds; buzzards and kestrels were recorded during all three surveys promoting the ecosystem value of this habitat type.

While no ground nesting was identified within the array, high levels of bird activity was noted throughout the surveys, with 30+ skylarks recorded singing within the array. Similarly, the wide margins (specifically left for birds) were used by large numbers of foraging and singing house martins as well as other species.

Invertebrates

In 2020 we recorded 73 different invertebrate species, with 28 species of butterflies; 3 moths; 5 dragon/damselflies; 7 beetles; 7 bees; 7 grasshoppers and crickets; as well as 16 other species. While we do undertake a variety of transect surveys for invertebrates where required, the majority of these results are from ad-hoc recordings during the surveys. As such these results are difficult to extrapolate; differences in weather conditions, timing of the surveys, amount of time taken to do the survey (i.e. sites with additional habitats to assess such as ditches, bat/bird boxes etc) would have taken longer to survey and some would have required multiple surveyors, increasing the chances to record more invertebrates. However, solar farms and the variety of habitats they encompass offer habitats suitable for a range of invertebrates and as such, even ad-hoc data is valuable until such a time as more detailed studies are available.

We found an average of 6.5 different invertebrate species per site per survey, but if you discard the surveys taken outside the peak survey window (May-August) the average number of invertebrates per survey was 7.6 different species. This doesn't account for abundance and given only 2 spiders and 1 slug was recorded during the surveys, it is assumed a lot of invertebrate activity was missed in the absence of targeted surveys.

A common blue butterfly on a birdsfoot trefoil flower within an array exterior.

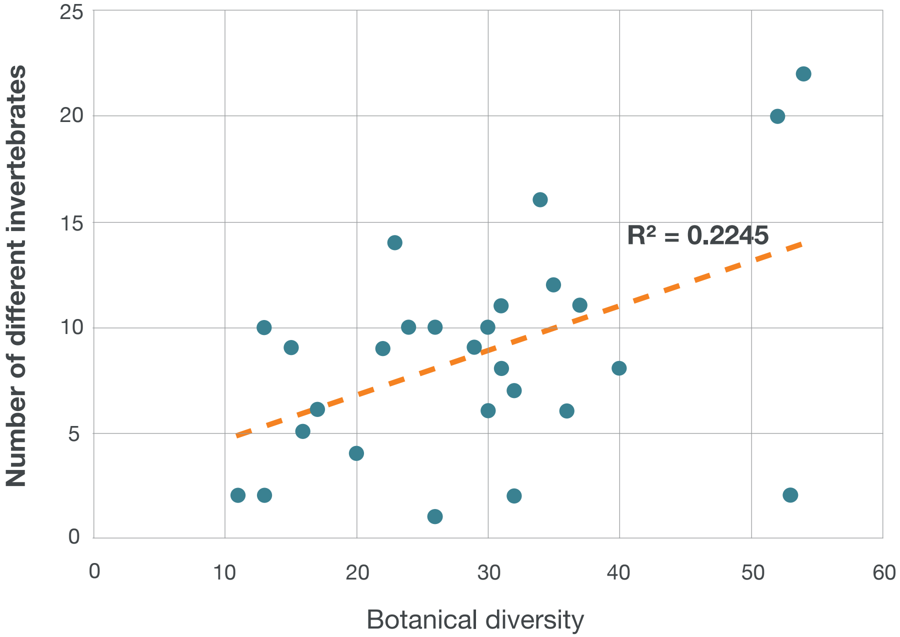
As in 2019, meadow brown was the most commonly recorded invertebrate, found on 76% of sites in 2020 and 71% of sites we surveyed in 2019. Recordings of bumblebees were markedly down on 2019, with red-tailed bumblebee recorded on 46% of sites and buff-tailed bumblebees on 33% of sites; in 2020 these species were only recorded on 24% and 18% of sites, respectively. However butterfly recordings increased and made up 60% of all the invertebrate recordings in 2020.

Of the 28 different butterfly species recorded, small heath and dingy skipper are Butterfly Conservation Trust High Priority species and Species of Principal Importance under the NERC Act 2006. Small heath was recorded on 12% of sites while dingy skipper was recorded on 6%. Dark-green fritillary, which is a Butterfly Conservation Trust Medium Priority species was recorded on a single site.

When comparing sites for which we have long term monitoring data, we found no significant relationship between the diversity of invertebrates recorded across the years. Nor did we find any relationship when looking at diversity of invertebrates when comparing age of sites to invertebrate diversity. However, when looking at management type, sites which are managed through cutting had an average of 10 different invertebrate species, while sites which are managed through grazing had an average of 6.9 different species. Looking at historic land use suggests sites which were a mixture of both pasture and arable were the most diverse, with an average of 11 different invertebrate species, compared to sites which were arable, which had 8 different species on average and formerly pasture sites had an average of 9.5 different species.

Sites with higher botanical diversity (recorded during botanical surveys) seemed to have higher recorded diversities of invertebrates. Statistical analysis indicates that there is no significant correlation at present within our data, as shown in the 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.

Diversity of invertebrates compared to botanical diversty



SOLARVIEW

A well seeded herb rich array exterior which provides habitat for a range of species, particularly invertebrates.

Case Study:

Carloggas – Good Energy

In a single visit to Carloggas Solar Farm, a 19ha solar farm, we recorded 16 different invertebrates. The most recorded on a site during a single survey. Prior to construction in 2015 it was a mixed farm, approximately half was arable and half improved pasture; the formerly arable fields were seeded by Habitat Aid as was the bare ground created within the pasture fields. Due to the size and complexities of the site, we undertake 30 botanical quadrats (split between the formerly arable and formerly pasture fields), additionally there are several bat and bird boxes installed around the site which required additional time on site and the use of two surveyors. This may in part account for the high diversity of invertebrates recorded, however, the size and diversity of habitats on site will also affect this. The grassland throughout both the previously arable and formerly pasture fields was above average in terms of botanical diversity and the solar farm is managed in accordance with the management plan.

Habitats within and around the site include mature woodland, tussock rich and scrubby field margins with marshy grassland and herb rich semi-improved grassland throughout the array interior. Specific food plants were sown to encourage rare butterflies including marsh fritillary, dingy skipper and narrow-bordered bee hawk-moth; while none of these species have yet been recorded it is hoped that through future monitoring they will be identified as the suitable habitat has now established.

Large skipper and marbled white butterflies recorded as part of ad-hoc sightings

Other Notable Species

We recorded 11 different mammal species using the sites in 2020 (including both soprano pipistrelle and brown long-eared bats found in boxes). All three of the UK's native newts were found on solar farms as well as common toads! Also recorded were grass snakes and common lizards, illustrating the diversity of life that can be found on solar arrays.

As in 2019, rabbits were the most commonly observed mammal, recorded on 45% of solar farms, up from the 40% they were recorded in during the 2019 surveys. While brown hares saw a further drop to 27% of monitored solar farms, down from the 32% of sites in 2019 and the 53% of sites monitored in 2018.

Evidence of foxes was recorded on only 12% of sites (compared to 28% of site in 2019), and 30% of solar farms were being actively used by badgers with evidence of foraging being found, a large increase on the 16% of solar farms found in 2019. New setts have also been recorded at the margins of solar farms, including in one instance an entrance directly under the perimeter fencing, highlighting how little these fences significantly fragment the habitat and suggesting high quality foraging opportunities within the array.

Roe deer were recorded on a greater percentage of solar farms, with evidence of deer found within 21% of the array interior or the field margins in 2020, up from the 12% in 2019. The solar farms monitored are fenced with typical 6ft deer proof fencing, however, this does not appear to be a challange for deer! In 2019, all solar farms found to be used by deer were grazed by sheep, this was not the case in 2020 when more than half (71%) of the solar farms which were used by deer were actually managed through cutting.

As in previous surveys, common species such as field voles (3% of solar farms), brown rats (3% of solar farms) and moles (12% of solar farms) were only recorded on an occasion which does not necessarily indicate an absence from the sites, but rather an under-recording of these less visible species. Given the abundance of predatory birds (barn owls, kestrels, red kite and buzzards) recorded during monitoring, it seems reasonable to assume that small mammal numbers are high in solar farms.

On one solar farm, where great crested newt monitoring was completed, a single torchlight survey was undertaken. All three species of native newt; smooth newt, palmate newt and great crested newt were recorded. Given this survey was only undertaken on one occasion on one solar farm, it would be very interesting to undertake more torchlight surveys of additional ponds within/adjacent to solar farms to better establish use of these habitats by amphibians. Similarly, common lizards were found one on site during the walkover, as were grass snakes. Reptile surveys typically require multiple site visits and so are not often carried out. As with great crested newt surveys, it would interesting to do additional surveys and gain further understanding as to how reptiles use solar farms.

Case Study:

Case Study: Sidlesham – Low Carbon

In an area known to be used by reptiles, the solar farm accommodated these species through careful design, which accommodated a large margin to the south of the site adjacent a tree lined ditch. This was protected throughout construction and has been allowed to develop into a tussock rich sward, with a narrow access track maintained as short grassland. A detailed reptile survey of this area, with artificial reptile refugia deployed and regularly checked over summer 2020, found common lizards and toads. With more than 3 times the number of adult lizards found in this area than the peak count in 2013 prior to construction of the array! The population within the field margins has increased from what was considered a “small” population to a “medium” population which is a clear success.

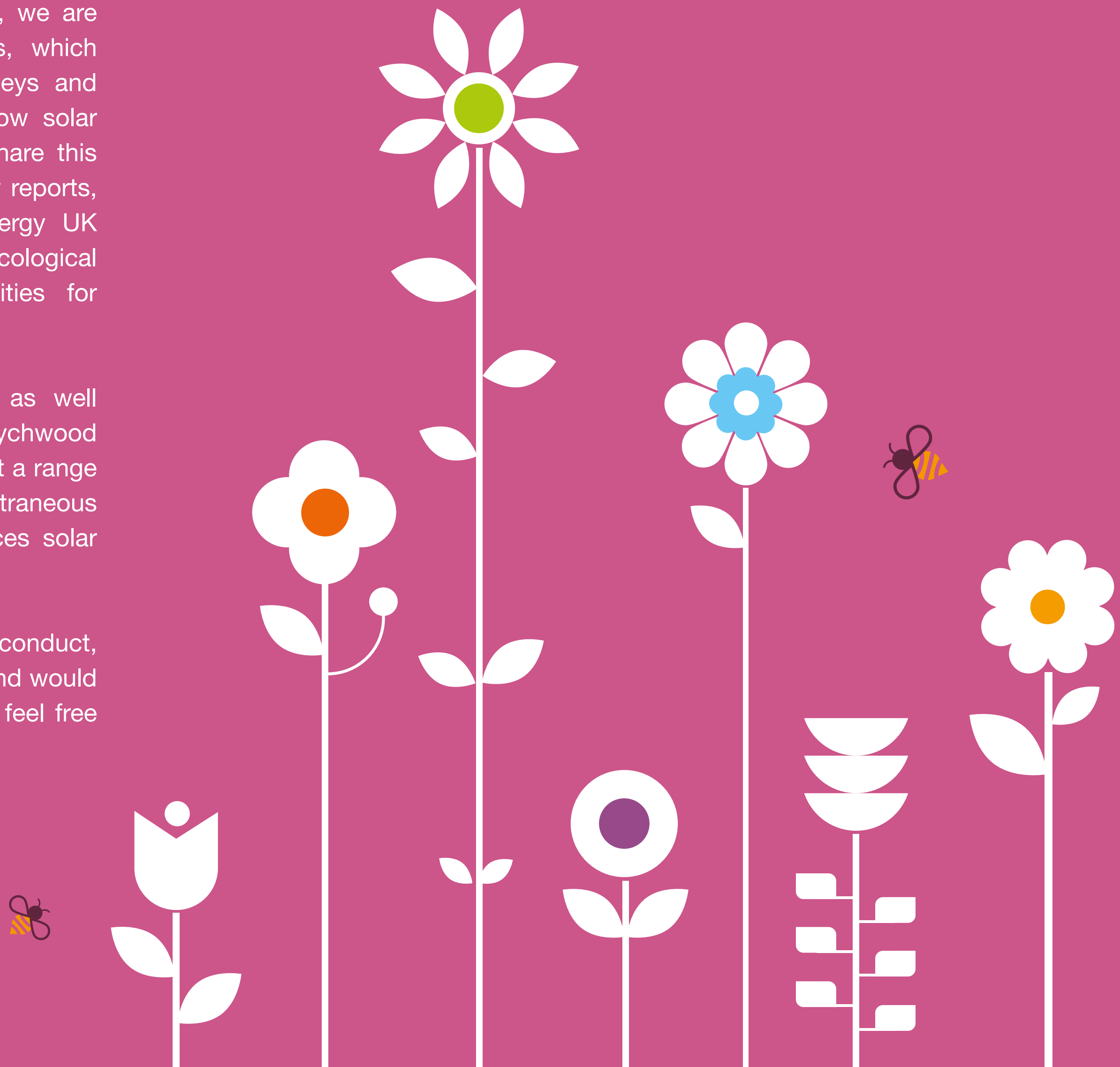
The array itself is grazed by sheep with different segments grazed at different times of the year and has a strip of species rich wildflower planting around the internal edge. Despite being fairly intensively managed compaired to the margins (with a varied 10-60cm tall sward throughout), suitable habitat for use by reptiles was found within the array interior as well. This area was not surveyed so presence of reptiles within the array has not yet been proven, however it is considered highly likely. The boundary fence, like almost all sites we monitor, is not dug in and so has large gaps at the base and in the mesh - this does not fragment the habitats on site, with the array interior being well used by rabbits.

As with previous years, the dataset used to create this report is the result of multiple companies appointing us to conduct ecological monitoring of solar farms throughout the country. This now annual report, though the third of its kind, remains a unique study.

Through our work within the solar sector from pre-planning surveys to long term post construction monitoring across the country, we are able to provide a valuable summary of our initial findings, which we use to underpin the way we conduct pre-planning surveys and prepare management plans, giving us real perspective on how solar farms are managed and perform long term. In an effort to share this experience within the sector we have prepared these Solarview reports, however we are looking forward to working with Solar Energy UK to compile an even larger report in future to ensure that ecological impact assessments are representative and the opportunities for ecological enhancement are maximised wherever possible.

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.

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.



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