Observations on the use of a solar park by Corn Buntings in southern England

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Abstract

Ground-mounted solar parks are the largest onshore renewable energy source in the UK. Despite this, relatively little is known about their impact on biodiversity compared to other land uses, particularly on ground-nesting farmland birds. In this study, we present the first evidence of nesting Corn Buntings *Emberiza calandra*, a red-listed species, or indeed any ground-nesting farmland bird on a solar park in the UK. We describe clutch sizes, number of fledglings, nest success rates and causes of nest failure for five Corn Bunting nests at Westmill Solar Park between 2019 and 2023, as well as 36 nests within an approximate 1 km radius from the solar park boundary. We also conducted focal watches to assess how farmland birds use solar parks during the breeding season. These revealed that Corn Buntings spent the greatest proportion of time within the solar park foraging. Several birds were also observed carrying food from the solar park to land outside the perimeter fence, suggesting these birds were 'commuting' to the solar park to forage during the breeding season. Although these observations are encouraging, Westmill Solar Park is currently the only solar park in the UK where ground-nesting farmland bird nests have been reported and differs from most other solar parks in the UK in its design and management. Further monitoring and research are therefore needed to understand more about the behaviour of farmland birds on a greater sample of solar parks, and which management interventions can promote favourable conditions for ground-nesting farmland birds on these sites.

Introduction

Construction of solar parks is set to increase over the coming years due to concerns about the finite supply of fossil fuels, global climate change and energy security. Ground-mounted solar photovoltaic (PV) facilities, or 'solar parks', recently surpassed wind energy as the most abundant onshore renewable land use in the UK (Jones *et al*. 2014; DENZ 2025), with projections that solar parks may constitute up to 0.72% of total land cover in the UK by 2050 (Blaydes *et al*. 2025). Early studies suggest the potential biodiversity uplift of solar parks is greatest in cropland, grassland, and barren terrain (Adeh *et al*. 2019), and they may therefore present opportunities to enhance local biodiversity (Randle-Boggis *et al*. 2020). Generally, lower management intensity on solar parks compared to surrounding landscapes can enhance biodiversity by increasing plant diversity and altering the composition of plant species (Lambert *et al*. 2023), with consequent benefits for a range of taxa (Graham *et al*. 2021; Blaydes *et al.* 2022). As solar parks are generally constructed on agricultural land in the UK (Palmer *et al*. 2019), farmland birds are more likely to be impacted by their construction than birds of other habitats. Further research is therefore needed to understand if solar parks can provide useful habitat for these species.

Agricultural intensification is widely considered to be the main driver of terrestrial biodiversity loss in Europe in the post-war period (Robinson & Sutherland 2002; Ekroos *et al*. 2016; Kehoe *et al*. 2017), reflected in the widespread declines of many farmland bird species (Donald *et al.* 2001). Their declines have largely corresponded with changes in agricultural management practices, with a variety of factors acting in concert (Reif 2013; Stanton *et al.* 2018; Rigal *et al.* 2023). These include the introduction of field drainage systems, extensive use of fertilisers and agrochemicals, loss and degradation of hedgerows, conversion of grassland to arable, a move away from mixed farms towards either arable or pastoral, and a general switch from spring to autumn sowing (Odderskaer *et al.* 1997; Gillings Fuller 1998; Brickle *et al*. 2000; Newton 2004; King *et al*. 2008; Cornulier *et al*. 2011; Aebischer *et al*. 2015; Walker *et al*. 2018). Together, these changes have negatively impacted populations of farmland birds through diminished food supplies and loss of nesting habitat (Crick *et al.* 1994; Green 1995; Evans *et al*. 1997; Wilson *et al.* 1997; Chamberlain *et al*. 1999; Brickle *et al.* 2000). Their conservation is therefore a priority.

The Corn Bunting *Emberiza calandra* is one farmland ground-nesting bird species which has suffered major population reductions in the post-war period in the UK, declining by around 83% between 1967 and 2023 (Massimino 2024), and it is red-listed in the latest 'Birds of Conservation Concern' (Stanbury *et al.* 2021). Key drivers of its decline largely mirror those of other farmland bird species, but include a reduction in invertebrate and weed abundance as a result of the use of agrochemicals, a switch from spring to autumn sowing, and a shift in agricultural intensity through the loss of sensitively managed unimproved grasslands and earlier cutting rotations (Crick *et al.* 1994; Brickle & Harper 2002; Perkins *et al.* 2013). One preliminary study recorded this species frequently using solar parks across multiple sites (Shotton 2019), but more research is required to quantify how this and other farmland bird species are using solar parks.

In the UK, the limited studies of birds on solar parks have generally comprised ecological appraisals by consultancy firms (Parker & McQueen 2013; Montag *et al.* 2016; Solar Energy UK 2023), with only one peer-reviewed study to date (Copping *et al.* 2025). These studies, as well as a small number from Europe (e.g. Jarčuška *et al.* 2024; Goławski *et al.* 2025), have all reported generally positive trends, including increased abundance and diversity of bird species on solar parks compared to control plots in surrounding arable land. However, whilst analyses of diversity and abundance are useful, so far there has been little attempt to quantify the behaviour of bird species using solar parks, or to understand if they have the potential to provide nesting habitat. Furthermore, no study has monitored ground-nesting bird breeding attempts in land surrounding solar parks. These insights are required not only to improve understanding of positive and negative impacts of solar parks on birds, but also to help inform management practices on operational sites.

Here, we present the first confirmed evidence of Corn Buntings nesting on a solar park in the UK, including nest success rates and causes of nest failures. We also compare these to

monitored nests in arable land and grassland adjacent to the solar park. Furthermore, we conducted focal watches of individual Corn Buntings to understand how these birds are using the solar park, recording the time spent performing a series of key behaviours to create ‘activity budgets’ for those birds using the site.

Methods

Study site

The study took place at Westmill Solar Park, Watchfield, Oxfordshire, a 5 MW capacity solar park with 36 PV array rows covering 12.1 Ha, installed in 2011. The site is owned by the Westmill Solar Co-operative and is managed with a strong emphasis on promoting biodiversity, with a minimal interference approach. During construction, the entire site was planted with a native wildflower seed mix, with large gaps in between the rows of solar panels and extensive boundaries around the solar array. This has led to a rich mosaic of grassland habitats and hedgerows around the site (plate 001). Before and during our study, the site was left uncut by machinery and ungrazed throughout the entire summer (April-September), with short periods of adaptive multi-paddock grazing by a small mixed herd of native breed sheep between October and March.

001. Images of Westmill Solar Park, Oxfordshire from the boundaries (left) and between a row of the solar array (right). ***Ben Secker***

Nesting evidence

Data on nesting Corn Buntings at Westmill Solar Park were collected by West Oxfordshire Farmland Group for this study, spanning five years between 2019 and 2023. The group have also been monitoring Corn Bunting nests on land adjacent to the solar park, within a radius of approximately 1 km. Standard BTO Nest Recording Scheme (Ferguson-Lees *et al*. 2011) methods were used to monitor nests, recording clutch sizes, number of fledglings, nest success rates and causes of nest failure. The data collected were used to compare these parameters between nests inside the solar park and those on the adjacent land. ArcGIS (Version 2.2.8; ESRI 2021) was used to map the locations of these nests, with success or failure indicated. During the late season visit, one Corn Bunting nest had recently fledged, so detailed photos of the nest site were taken.

Focal watches

Focal watches were carried out to quantify how Corn Buntings were using Westmill Solar Park by observing key behaviours. Two visits to the site were completed during the summer of 2023 to conduct fieldwork: once in early June, and once in late July, to cover the peak of the breeding season for Corn Buntings (Ferguson-Lees *et al.* 2011). Focal watches were completed between 08.30 hrs until 17.00 hrs, due to restrictions in site access, although the middle of the day was avoided as bird activity is generally reduced during this period (Robbins 1981). One focal watch per bird was completed at each visit. Succeeding watches were conducted from different parts of the site, at least 100m away from the preceding watch to reduce the risk of sampling the same bird multiple times. A focal watch was carried out by

locating an individual Corn Bunting and observing it with binoculars from a suitable distance, around 20 to 50 metres, for between 10 and 30 minutes, or until the bird disappeared, whichever occurred sooner. A minimum of 10 minutes was considered enough time to get a representative sample of the behaviour of a bird on the site after consideration of other studies of focal watches of bird species (e.g. Drachmann *et al.* 2000; Ridley *et al.* 2007). Behaviour and location were recorded by speaking into a Dictaphone (iPhone 13) every time a bird's behaviour changed, allowing activity budgets to be calculated later. To describe the activity budget, the behaviours observed were divided into six mutually exclusive categories: singing, resting, interacting with other Corn Buntings, foraging, carrying nesting material, and carrying food. Focal watch data were not analysed at the level of the individual as birds were not colour ringed, meaning it was difficult to tell birds apart in the field with certainty. Therefore, focal watch data are pooled across each visit to give a proportion of the total time spent on site observed in different key behaviours.

Results

Nesting evidence

A total of five Corn Bunting nests were recorded at Westmill Solar Park across 2020, 2022 and 2023 (2, 2, and 1 nests, respectively), the locations of which are shown in fig. 1. Four of the five nests were located within the solar array, and the fifth was located within the boundaries of the site. Fig. 1 also includes the locations of 36 other nests that were monitored around the solar park. All five nests recorded inside the solar park were successful. These nests had a mean (± SD) clutch size of 4.2 ± 0.8 and fledged 3.8 ± 0.4 chicks. The 36 nests outside the perimeter of the solar park had a success rate of 61.1%. Those nests that were successful had a mean clutch size of 3.9 ± 1.2 and fledged on average 3.8 ± 0.2 chicks. Of the unsuccessful nests, 64.2% failed by egg predation, 21.4% failed by predation of nestlings, and the remaining 14.3% failed with unhatched eggs.

The only nest identified within the solar park in 2023 was located between the panels at the northern end of the site, details of which are shown in fig. 2. The nest was located 28.3 m away from the perimeter fence. The female produced five eggs, all of which subsequently hatched, and all chicks fledged successfully.

Fig. 1. Corn Bunting nesting locations in years where Corn Buntings attempted to nest on the solar park, in 2020, 2022, and 2023. Green dots indicate successful nests, red dots indicate unsuccessful nests. The red line indicates the perimeter of the solar park.

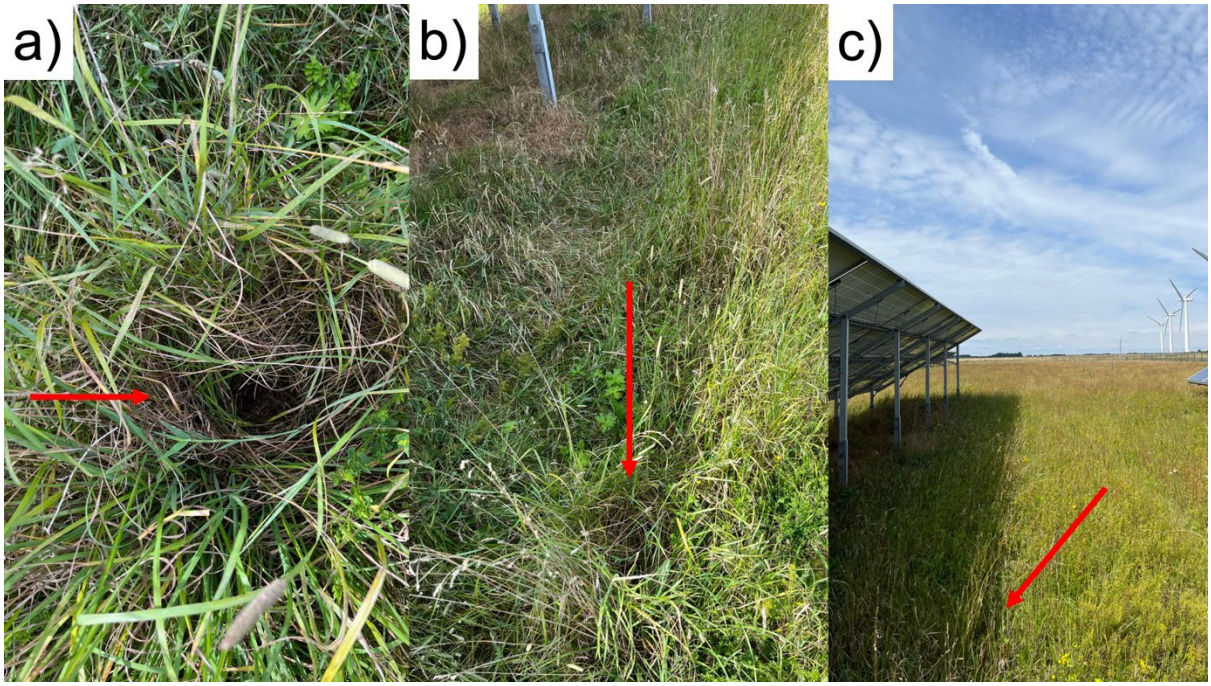

Fig 2. *Details of the location of a Corn Bunting nest found in 2023 on the community-owned solar park. Images illustrate a) close-up of the nest, b) vegetation structure and concealment, and c) the location between the panels towards the end of the first row in the array at the northern end of the site. The red arrows indicate the location of the nest. All images were taken during the late season visit after the nest had fledged.* ***Ben Secker.***

Focal watches

In total, we conducted focal watches of 11 individual Corn Buntings using the site during the early season visit, and 12 during the late season. These birds spent the majority of their time on the site foraging and singing, with a small increase in the former, and decrease in the latter observed between the two visits (fig. 3). Resting and interacting with other Corn Buntings were the next most common behaviours. Birds were seen carrying food for a greater proportion of time during the late-season visit, whereas they spent less time carrying nesting material during the late-season visit compared to the early season visit (fig. 3).

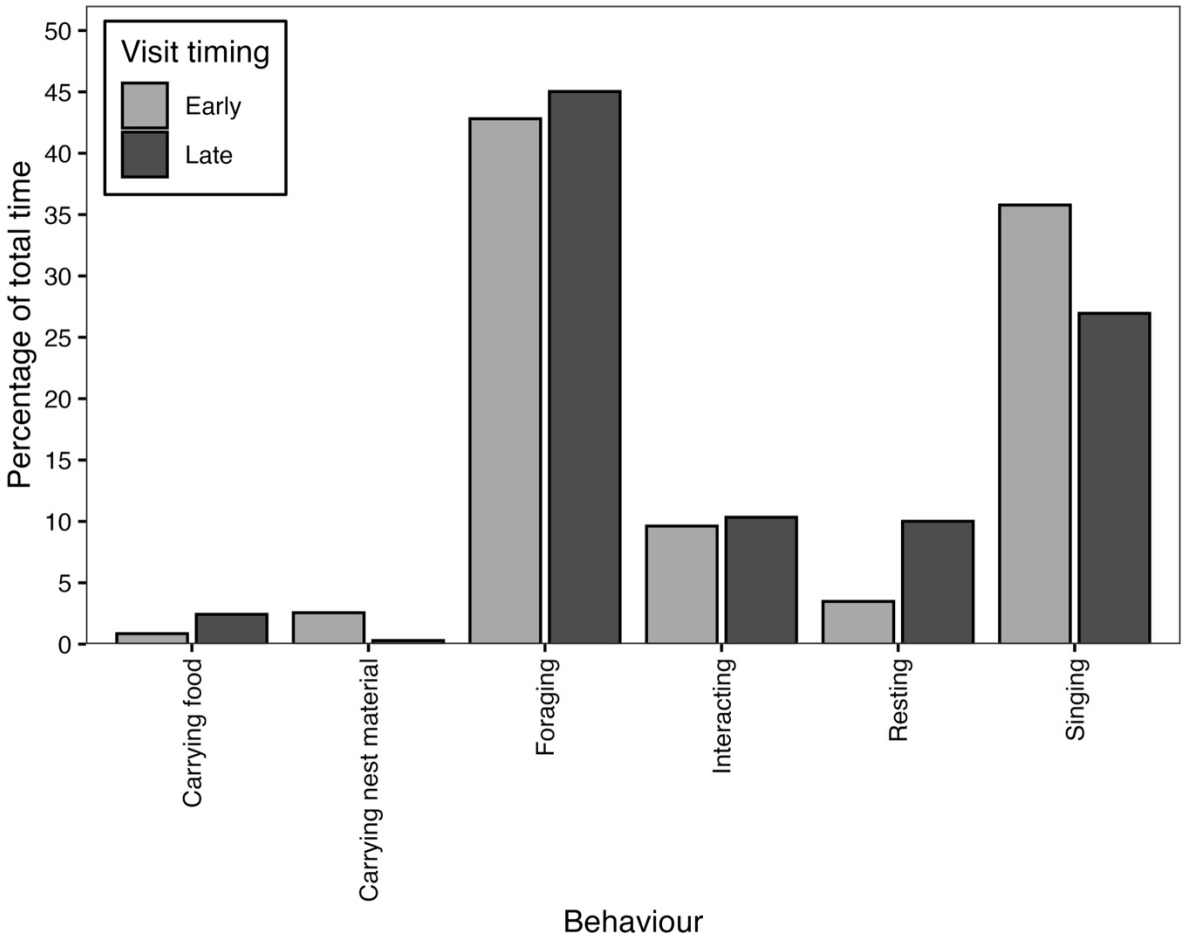

Fig. 3. Percentage of time Corn Buntings spent exhibiting each behaviour in focal watches at Westmill Solar Park during the early-season vs late-season visits.

Discussion

The impact of solar parks in relation to ground-nesting bird conservation has been a topic of contested debate over recent years, yet the true potential of these sites to provide useful habitat for these species is currently unclear. Evidence from this study indicates that Westmill Solar Park was actively used by Corn Buntings during the breeding season, including both for nesting and foraging.

In three of the five survey years between 2019 and 2023, West Oxfordshire Farmland Bird Group recorded nests within the boundary of Westmill Solar Park. In total five nests were found, all of which successfully fledged young. Although the number of nests within the solar park was small, these observations show that Corn Buntings can nest successfully within such sites. Within the solar park itself, larger distances between solar panels and larger margins, compared to many industrial solar parks (plate 001), are likely preferred by Corn Buntings and offer a more 'open' solar park design. These features likely provide more space to nest and forage away from the panels, providing more favourable conditions for breeding Corn Buntings than may typically be found on most solar parks. More detailed research is needed to determine optimal conditions for Corn Buntings and other farmland birds on solar parks.

The farmland adjacent to the solar park follows a more traditional and regenerative arable rotation than typical modern arable farmland (Robinson & Sutherland 2002), and hosts a large array of semi-natural habitats which are known to benefit ground-nesting farmland birds (Vickery *et al.* 2001; Li *et al*. 2023; Rösch *et al*. 2023). This may be a key driver of the relatively high success rate of nests in land adjacent to the solar park in our study population, which was around 10% greater than the highest success rates observed by two comparable studies of Corn Buntings in an agricultural setting in the UK (Brickle *et al*. 2000; Perkins *et al*. 2013). It can therefore be reasonably assumed that the wider landscape had more favourable conditions for nesting Corn Buntings than in many intensive arable areas, which could explain the nesting attempts within the solar park itself. Given the apparent absence of ground-nesting farmland bird nests on most solar parks in the UK, further studies may look to monitor nests in more conventional intensive arable farmland surrounding solar parks, which would help to understand their potential value on a more widespread scale.

For those nests that did fail in the farmland surrounding the solar park, predation was the most common cause. Protection from predators may therefore be an important factor in the success of nests within the solar park. Specifically, fences may present a barrier to mammalian predators such as Red Fox *Vulpes vulpes* and European Badger *Meles meles* (Maag *et al.* 2022), and panels could potentially reduce detection by aerial predators (Nordberg *et al*. 2021). Existing studies of predator exclusion and control demonstrate that whilst they can increase hatching success and post-breeding population size, they generally have little impact on the wider population (Coté & Sutherland 1997; Newton 1998). Overall, whilst the results from our study population are encouraging, Westmill Solar Park hosts relatively few nesting attempts each year, so its benefits for the wider population as a nesting habitat are probably limited.

Focal watches suggest that Westmill Solar Park was an important foraging area for Corn Buntings during the breeding season; the birds we observed spent the greatest proportion of time within the solar park foraging. We also observed birds with nests in the adjacent farmland carrying food from the solar park to their nests in both the early and late season visits, travelling approximately 20–750 m between their nests and favoured foraging locations. Other studies have observed a greater abundance of ground-foragers within solar parks compared to grassland control plots (Jarčuška *et al.* 2024), as well as a greater diversity and abundance of species on solar parks managed with biodiversity improvement measures compared to intensively managed solar parks and arable control plots (Copping *et al*. 2025). Indeed, Copping *et al.* (2025) found that Corn Bunting density was substantially greater on solar parks with biodiversity improvement measures, compared both to solar parks which were managed intensively and to arable control plots. It is therefore plausible that Corn Buntings in our study population may have been preferentially 'commuting' to solar parks from adjacent farmland to forage, capitalising on the abundant invertebrates on the solar park – a major component of their diet during the breeding season (Madge & de Juana 2020). This has also

been observed in Skylarks (Secker 2024), another red-listed ground-nesting farmland bird species (Stanbury *et al*. 2021). Blaydes *et al*.'s (2021) review suggested that solar parks could be important sources of nutrition to pollinators through late-flowering species. Improved invertebrate foraging resources on solar parks could therefore help to fill a similar 'hunger gap' for farmland bird species, as food availability declines in the wider landscape as the breeding season progresses (Donald *et al*. 2001; Douglas *et al*. 2010; Wilson *et al.* 2005).

The low-intervention management at Westmill Solar Park may have facilitated a high abundance of invertebrates across the site, subsequently generating favourable nesting and foraging conditions for Corn Buntings. However, further work is needed to determine which management interventions are practically feasible and provide the greatest biodiversity uplift on solar parks. Increasing both pre- and post-construction monitoring efforts of bird populations on solar parks would provide more reliable baselines upon which to implement management decisions. More advanced behavioural studies using novel techniques, such as GPS tags which may soon be feasible in studies of ground-nesting bird behaviour (Sáez-Gómez *et al*. 2025), present an opportunity to monitor spatial habitat use more accurately. Such work would help to highlight the scale at which solar parks can benefit wildlife in the surrounding landscape and would help to inform both researchers and industry professionals about the most effective ways to maximise biodiversity benefits of solar parks. More investment in research would also help to alleviate public anxieties around the impacts of solar parks on wildlife, which was the most common concern raised by the public in a study by Roddis *et al.* (2020).

Whilst the results from our study are encouraging, Westmill Solar Park is currently the only solar park in the UK where the nests of ground-nesting birds have been confirmed and monitored, and the sample size is small. Consequently, it is unlikely that ground-nesting birds are currently using solar parks to nest on a wide scale across the UK. However, the results do show that when managed favourably to promote biodiversity, solar parks can provide useful habitat for farmland birds, particularly as a foraging resource.

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