Avian Use of Photovoltaic Solar Energy Facilities in New York and Western Massachusetts:

Bird Community Composition

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NEW YORK STATE

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Avian Use of Photovoltaic Solar Energy Facilities in New York and Western Massachusetts: Bird Community Composition

Final Report

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Abstract

The rapid expansion of photovoltaic (PV) solar energy in the Northeastern U.S. presents both challenges and opportunities for breeding bird conservation, particularly in agricultural landscapes where grassland, shrubland, and aerial insectivorous birds have experienced long-term population declines. DNV Energy USA Inc. (DNV) evaluated avian use of operational, ground-mounted PV solar facilities in comparison to paired reference sites (e.g., "control" sites) in New York and Western Massachusetts by comparing bird occupancy, relative abundance, species richness, and vegetation structure. Surveys were conducted during the breeding seasons at 9 PV facilities and 9 paired controls in 2021 and at 13 PV facilities and 13 paired controls in 2022 using standardized point counts and vegetation sampling, with a qualitative assessment of nest monitoring at a subset of sites. Statistical analyses included occupancy models and generalized linear mixed models to assess differences between PV solar sites and paired reference controls, accounting for year and site-level variability.

Species-specific occupancy analyses revealed varying responses to PV solar development. Predicted occupancy was higher at solar sites for song sparrow (*Melospiza melodia*), American robin (*Turdus migratorius*), tree swallow (*Tachycineta bicolor*), and house finch (*Haemorhous mexicanus*) in one or both study years. In contrast, two grassland-associated species, including bobolink (*Dolichonyx oryzivorus*) and Savannah sparrow (*Passerculus sandwichensis*), had lower predicted occupancy at solar sites relative to paired reference sites, particularly in the second study year. Mean predicted bird abundance and species richness per point count were slightly higher at PV solar sites than paired reference sites in both years, although differences were small and not statistically significant. Habitat guild analyses showed higher abundances of urban-associated, open-woodland, and marsh species at PV solar sites, while forest-associated species were less abundant within solar facilities.

The mean vegetation height did not differ between PV solar and paired reference sites; however, vegetation density was significantly higher at solar sites, and woody regeneration (seedlings and saplings) was substantially lower within PV solar facilities, likely due to routine site maintenance. Preliminary nest monitoring and incidental observations documented frequent use of solar infrastructure for nesting by species such as house finch and American robin, and limited ground-nesting within vegetation by song sparrows. Collectively, these results indicate that PV solar facilities in agricultural landscapes can support diverse breeding bird communities, but species-specific responses vary and appear to be influenced by vegetation structure, site context, and management practices. Notably, two grassland species, bobolink and Savannah sparrow, were far less abundant within the PV sites, suggesting that these facilities may provide less suitable breeding habitat for grassland specialists than surrounding grassland habitats and agricultural lands.

Keywords

photovoltaic, solar energy, breeding birds, agricultural landscapes, bird occupancy, avian abundance, species richness, vegetation structure, grassland birds, shrubland birds, land-use change

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Acronyms and Abbreviations

µ	micro or occurrence
ψ	wave function or occupancy probability
±	plus or minus
<	less than
>	greater than
≥	greater than or equal to
AC	alternating current
AICc	Akaike’s Information Criterion (adjusted for small sample size)
CI	confidence interval
COD	commercial operation date
DC	direct current
DNV	DNV Energy USA Inc.
GHG	greenhouse gas
GLMM	generalized linear mixed model
GOF	goodness of fit
NaNs	Not a number
NLCD	National Land Cover Database
NYS	New York State
NYSERDA	New York State Energy Research and Development Authority
PERMANOVA	permutational multivariate analysis of variance
PV	photovoltaic
SD	standard deviation
SE	standard error
U.S.	United States
UK	United Kingdom
USGS	U.S. Geological Survey

Units of Measurement

ha	hectare
m	meters

MW	megawatts

Executive Summary

The rapid expansion of photovoltaic solar energy in the Northeastern U.S. is transforming landscapes, creating both challenges and opportunities for breeding bird communities. This study evaluated how breeding birds use ground-mounted photovoltaic solar facilities in New York State and Western Massachusetts, and how these sites compare to nearby reference areas that reflect pre-construction land cover. The research was conducted over the 2021 and 2022 breeding bird seasons and examined bird occupancy, abundance, species richness, vegetation structure, and nesting behavior.

ES.1 Methods

A total of 13 operational solar facilities and 13 paired reference sites were surveyed. Standardized point-count methods were used to record birds, and vegetation sampling was completed to compare the habitat within solar facilities and paired reference sites and make inferences about how birds respond to vegetation structure and management. Nest monitoring was conducted at two solar facilities in 2022, supplemented by incidental nest observations at other sites. The study used two primary analytical methods to evaluate differences between solar facilities and reference sites:

- **Occupancy modelling** was used to estimate the probability that a species was present at a site while accounting for imperfect detection. These models incorporated repeated surveys at each point and included variation among sites and years. Fourteen species with sufficient detections were analyzed.
- **Generalized linear mixed models** were used to compare total bird abundance and species richness between solar facilities and reference sites. These models accounted for differences among sites and years and were designed to handle the large number of zero counts that often occur in bird surveys.

Vegetation structure was analyzed using similar mixed-model approaches to compare vegetation height, density, and woody regeneration between solar and reference sites.

ES.2 Key Findings

- **Occupancy.** Several generalist and edge-associated species showed higher predicted occupancy at solar facilities, including song sparrow, American robin, tree swallow, and house finch. For example, in 2022, song sparrow occupancy was estimated at 0.97 at solar sites compared to 0.63 at reference sites. In contrast, grassland-associated species such as bobolink and Savannah sparrow had lower predicted occupancy at solar facilities.
- **Abundance and species richness.** Modelled abundance and species richness per point count were marginally higher at solar sites in both years, though differences were small and not statistically significant. These patterns suggest that solar facilities can support diverse bird communities, but species responses vary widely.
- **Vegetation.** Vegetation height was similar between solar and references sites, but vegetation density was significantly higher within solar facilities. Woody regeneration was substantially lower at solar sites, likely due to routine vegetation management. These vegetation patterns help explain species-specific responses: dense herbaceous cover may benefit some open-habitat species, while reduced woody structure limits habitat for birds associated with forests and shrublands.
- **Nest monitoring.** Nest monitoring documented extensive use of panel racking structures by species such as house finch and American robin. Song sparrow was the only species confirmed nesting within ground vegetation at the two solar sites that were monitored for nests.

ES.3 Management Implications

The findings suggest several opportunities to enhance ecological outcomes at solar facilities:

- Vegetation management that maintains early-successional habitat can benefit many species.
- Minimizing mowing during the breeding season may reduce disturbance.
- Facility layout and scale may influence habitat suitability for area-sensitive species.
- Seed mixes and vegetation composition can be selected to support diverse bird communities.
- Long-term monitoring tools such as acoustic recorders could improve understanding of bird use in solar facilities.

ES.4 Conclusion

Overall, the study provides evidence that photovoltaic solar facilities can support diverse bird communities in the Northeastern U.S., but species-specific responses depend on vegetation structure, site context, and management practices. These findings can inform future solar siting and management decisions to enhance ecological benefits while minimizing negative impacts on sensitive bird species.

1. Introduction and Objectives

The rapid growth of renewable energy in the U.S., including photovoltaic (PV) solar energy, has the potential to reduce the effects of climate change on migratory birds by mitigating greenhouse gas (GHG) emissions; however, it often requires modification of land cover that may affect its value as habitat for bird species. Generally, utility-scale PV solar facilities require approximately 5–10 acres (2–4 ha) of land per megawatt of production (Ong et al. 2013). The nature and extent of land clearing vary by facility, but construction of a PV solar facility may include tree clearing, grading, and compaction of areas for the installation of collector arrays (Farmer et al. 2016). As a result, land modifications at PV solar facilities likely lead to habitat loss for some bird species; however, depending on site context and other factors (e.g., landscape features, vegetation management strategies), solar facilities can also create new habitat for other species.

In the Northeastern U.S., PV solar facilities are typically installed on agricultural lands or old agricultural fields that are in succession (e.g., early-successional habitat returning to forest), or on undisturbed sites comprising primarily shrub-scrub habitat or forests of varying composition (e.g., deciduous, mixed) and age. Recent assessments indicate that bird guilds typically associated with farmlands have experienced significant population declines, including grassland birds and aerial insectivores, with population losses of 53% and 32%, respectively (Rosenberg et al. 2019). Additionally, although they are less area-sensitive than grassland bird species, shrubland bird species have also shown a 16.5% population decline based on recent assessments of North American Breeding Bird Survey data collected between 1966 and 2013 (Stanton et al. 2018). These declines are primarily attributed to the loss of scrub-shrub habitat for shrubland bird species (Schlossberg and King 2007) and agricultural grasslands for grassland bird species and aerial insectivores (e.g., hayfields, pastures) (Morgan and Burger 2008) as well as from human development (housing and commercial) and reforestation (Askins 1993; King and Schlossberg 2014).

Empirical evidence of habitat-related outcomes for birds from solar development is limited because effects are indirect and difficult to evaluate. The limited studies that have evaluated the habitat value of PV solar sites to birds and other wildlife have produced varied results among species, guilds, habitats, and regions. For example, early studies that examined the biodiversity of grassland herbs, bees, and butterflies at four operational PV arrays in the United Kingdom (UK) found that all sites had higher diversity values than control plots, regardless of land management regime (i.e., wildflower meadows or pasture with agricultural grasses)

(Parker and McQueen 2013). Although the Parker and McQueen study did not formally survey for birds, several species, including species of conservation concern in the UK, such as skylark (*Alauda arvensis*) and reed bunting (*Emberiza schoeniclus*), were observed using habitats within the PV solar arrays.

Other recent studies at solar facilities in the U.S. and South Africa have shown similar, varied results. For instance, avian diversity observed at five PV arrays at U.S. airports in Arizona, Colorado, and Ohio was lower than in adjacent grasslands (DeVault et al. 2014); however, overall bird densities at the PV arrays were more than twice those of adjacent grasslands. Results of the airport study also varied by species, with many small passerines more abundant at PV facilities compared with adjacent grasslands, while corvids and raptors were generally less abundant (DeVault et al.). Similarly, a study conducted in South Africa documented reduced bird species richness and density within a PV solar facility compared to adjacent areas, but with varied responses among species and species guilds (Visser et al. 2019). In general, shrubland species richness was lower at the PV solar facility, whereas open-country/grassland species richness tended to be higher there, and densities of these species did not differ between the facility and reference sites. Additionally, Visser et al. noted that generalist species were represented equally in the facility and adjacent lands, and that none of the species that appeared to be displaced were threatened or rare, and they concluded that the facility had little impact on the bird community as a whole.

As these studies suggest, PV solar facilities are likely to attract some avian species, due to project infrastructure, vegetation characteristics, and other management practices commonly associated with solar operations. For instance, the availability of shade and perches may increase the attractiveness of PV sites to birds (DeVault et al. 2014), or that they might supplement or complement habitat resources for foraging, hunting, and nesting (Visser et al. 2019). For example, researchers documented granivore species drinking at an evaporation pond associated with a PV facility, and several species were found nesting on the solar panel supports (Visser et al.). The latter behavior has also been recorded at facilities in other regions (Hernandez et al. 2014). The availability of safe nesting areas may also be an attractant to breeding birds, as chain-link security fencing that is typically installed around solar facilities may deter ground predators (Smith et al. 2010). Conversely, PV sites are expected to reduce numbers of other species, such as grassland specialists, who are known to be intolerant of vertical structures such as shrubs, which reduce populations in grassland areas (Ribic et al. 2009; Vickery et al. 1994).

Project layout and vegetation management practices within and at the margins of solar facilities are also likely to influence habitat availability and site attractiveness to birds. More recently, a growing body of empirical research from Europe suggests that PV solar facilities, particularly those embedded within intensively managed agricultural landscapes, can support higher bird abundance and diversity than surrounding farmland under certain conditions. In Slovakia, Jarčuška and colleagues (2024) documented significantly greater bird species richness, Shannon diversity, and abundance of invertebrate-eating and ground-foraging birds within ground-mounted PV solar parks compared to paired agricultural control plots, with effects most pronounced at facilities developed on former arable land. Differences in community composition indicated that PV solar parks increased beta diversity (difference in species composition between ecosystems or sampling sites) at the landscape scale, likely due to increased structural heterogeneity created by panel infrastructure and associated vegetation communities. Similarly, in Great Britain, Copping and colleagues (2025) found that breeding bird abundance and species richness were substantially higher at six PV solar farms than on adjacent arable farmland, but responses varied strongly with vegetation management and habitat at the PV solar farms. Solar farms promoted mixed habitats characterized by taller swards, wildflowers, and woody boundary features, supporting nearly three times the bird abundance and more than twice the species richness of both simple habitats and intensively managed solar farms, as well as of arable farmlands used as reference sites. These findings underscore the importance of management intensity and habitat complexity in mediating avian responses to solar development. In the Northeastern U.S., management practices that keep vegetation in early successional stages could be particularly beneficial to grassland and shrubland species (Oehler et al. 2006). However, little is known about the impacts that different vegetation management strategies employed at PV solar facilities in the region have on bird communities, and improving our understanding of these relationships has been identified as a key research priority (Hernandez et al. 2014; Royal Society for the Protection of Birds 2014; Taylor et al. 2019).

1.1 Goals

The primary goal of the research presented in this report was to understand potential impacts of operational PV solar facilities (hereafter "PV solar sites") in New York and Western Massachusetts and the site-level and landscape factors that may influence breeding birds associated with the selected solar facilities and adjacent habitats. The specific objectives of this study were to:

1. Identify and document avian species and communities associated with operational PV solar sites and paired reference sites by conducting point count surveys during the breeding season
2. Identify associations among species occupancy, relative abundance, richness, and habitat structure of PV solar sites and reference sites
3. Provide insights for PV solar siting and management decisions based on results

The results of the research presented herein are expected to help inform future PV siting decisions and spatial planning, and identify effective management practices to improve benefits to birds while reducing potential negative impacts from PV solar energy development in New York.

2. Methods

This section describes the methods of our study which were designed to evaluate differences between the PV solar sites and paired reference sites, including study site selection, field data collection, and statistical analyses.

2.1 Site Selection and Study Area

For this study, 13 PV solar sites (Figure 1) were selected in coordination with 3 solar facility operators based on the characteristics of each solar site (e.g., ecoregions, former land use/land cover, project footprint, and commercial operation date; Table 1). Land cover types (e.g., cultivated crop, hay/pasture) were assessed using publicly available datasets, including the U.S. Geological Survey (USGS) National Land Cover Database (NLCD) (Dewitz 2019; USGS 2014), to identify the previous land use and land cover of each solar facility. Paired reference sites that reflect the relative preconstruction conditions of each solar site were then selected based on the general land cover types identified as dominant at each solar site prior to development and the proximity to each solar site (e.g., within a 20-mile radius; Table 2). The boundaries of the selected solar and paired reference sites were delineated in ArcMap 10.8.1 Google Earth aerial imagery, and ortho imagery (e.g., Bureau of Geographic Information, Commonwealth of Massachusetts, Executive Office of Technology and Security Services).

The study area includes the 13 selected operational PV solar sites and their corresponding paired reference sites for a total of 26 survey sites distributed across 9 counties in New York and 2 counties in Massachusetts. The PV solar sites range in size from 10 to 40 acres (4 to 16 ha) and have solar power generation capacities of 1.9 to 7.8 MW. The PV solar and paired reference sites are distributed across five Level III and seven Level IV ecoregions (Bryce et al. 2010; Griffith et al. 2009). Generally, the PV solar and reference sites are located in landscapes dominated by agriculture with elevations ranging from 100 to 600 m above sea level. The PV solar sites and the paired reference sites were at similar elevations.

Figure 1. Map of Study Area for Avian Use Surveys at Photovoltaic Solar Facilities

The light blue circles represent the general locations of the nine PV solar facilities, and the blue triangles represent the general locations of the nine selected paired reference sites that were surveyed in both 2021 and 2022. The orange circles represent the general locations of the four PV solar facilities, and the orange triangles represent the general locations of the four selected paired reference sites surveyed in 2022.

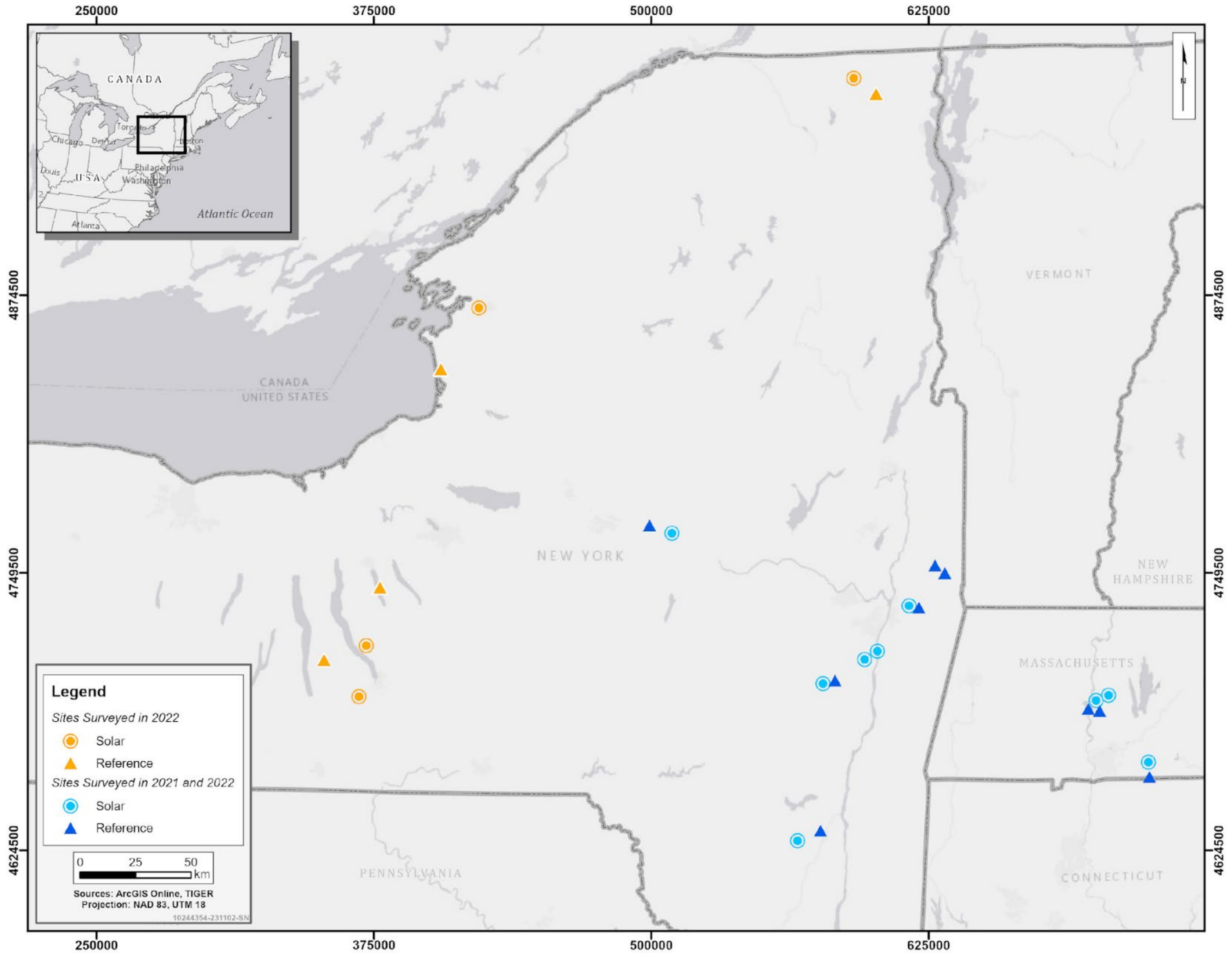


Table 1. Solar Study Project Sites for Avian Use Surveys at Operational Photovoltaic Solar Facilities

Includes dominant landcover, ecoregions, project COD, project location (county, state), project footprint (acres), and project capacity (megawatts, AC/DC, if reported).

Source: Bryce et al. (2010), Griffith et al. (2009).

Site Reference Name	Dominant Former Land Cover	Level III Ecoregion[a]	Level IV Ecoregion[a]	COD	Project Location	Project Footprint (acres)	Project Capacity (MW [ac/dc])	No. of Point Count Plots
Albany 1	Cultivated crops	Northeastern Coastal Zone	Hudson Valley	2017	Albany County, NY	40.0	7.8 MW [dc]	9
Albany 2	Hay/pasture	Northeastern Coastal Zone	Hudson Valley	2016	Albany County, NY	13.5	2.7 MW [ac]	4
Albany 3	Hay/pasture	Northern Allegheny Plateau	Glaciated Low Allegheny Plateau	2019/2020	Albany County, NY	23.2	7 MW	5
Clinton 1	Deciduous forest	Eastern Great Lakes Lowlands	Upper St. Lawrence Valley	2019	Clinton County, NY	8.9	1.7 MW [dc]	3
Herkimer 1	Hay/pasture	Eastern Great Lakes Lowlands	Mohawk Valley	2019/2020	Herkimer County, NY	14.8	2.96 MW	4
Jefferson 1	Hay/pasture	Eastern Great Lakes Lowlands	Ontario Lowlands	2018	Jefferson County, NY	9.2	2.6 MW [dc]	4
Rensselaer 1	Cultivated crops	Northeastern Highlands	Rensselaer Plateau	2019	Rensselaer County, NY	26.8	5.36 MW	6
Tompkins 1	Cultivated crops	Northern Allegheny Plateau	Finger Lakes Uplands and Gorges	2021	Tompkins County, NY	36.0	6.8 MW	6
Tompkins 2	Cultivated crops	Northern Allegheny Plateau	Finger Lakes Uplands and Gorges	2018	Tompkins County, NY	30.1	7.5 MW [dc]	6
Ulster 1	Mixed forest	Ridge and Valley	Northern Glaciated Limestone Valleys and Terraces	2019	Ulster County, NY	20.0	5.58 MW	5
Hampden 1	Hay/pasture	Northeastern Coastal Zone	Connecticut Valley	2014	Hampden County, MA	12.5	3 MW	3
Hampshire 1	Cultivated crops	Northeastern Coastal Zone	Connecticut Valley	2019/2020	Hampshire County, MA	23.2	4.64 MW	4
Hampshire 2	Hay/pasture	Northeastern Coastal Zone	Lower Worcester Plateau/Eastern Connecticut Upland	2016	Hampshire County, MA	10.1	1.9 MW	4

Table 2. Paired Reference Sites for Comparing to Avian Use Surveys at Operational Photovoltaic Solar Facilities

Includes dominant landcover, ecoregions, site location (county, state), and site or parcel footprint (acres).

Site Reference Name (Paired with Solar Sites)	Dominant Land Cover	Level III Ecoregion[a]	Level IV Ecoregion[a]	Site Location	Site Footprint (acres)
Albany 1	Cultivated crops	Northeastern Highlands	Taconic Foothills	Rensselaer County, NY	124.6
Albany 2	Hay/pasture	Northeastern Highlands	Taconic Foothills	Rensselaer County, NY	117.5
Albany 3	Hay/pasture	Northern Allegheny Plateau	Glaciated Low Allegheny Plateau	Albany County, NY	39.2
Clinton 1	Deciduous forest	Northeastern Highlands	Northern and Western Adirondack Foothills	Clinton County, NY	95.4
Herkimer 1	Hay/pasture	Eastern Great Lakes Lowlands	Mohawk Valley	Herkimer County, NY	27.4
Jefferson 1	Hay/pasture	Eastern Great Lakes Lowlands	Ontario Lowlands	Jefferson County, NY	11.6[d]
Rensselaer 1	Cultivated crops	Northeastern Highlands	Rensselaer Plateau	Rensselaer County, NY	41.3[b]
Tompkins 1	Hay/pasture	Northern Allegheny Plateau	Finger Lakes Uplands and Gorges	Cayuga County, NY	46.0
Tompkins 2	Hay/pasture	Northern Allegheny Plateau	Finger Lakes Uplands and Gorges	Schuyler County, NY	207.3[c]
Ulster 1	Mixed forest	Ridge and Valley	Northern Glaciated Shale and Slate Valleys	Ulster County, NY	116.0
Hampden 1	Hay/pasture	Northeastern Coastal Zone	Connecticut Valley	Hampden County, MA	11.6
Hampshire 1	Cultivated crops	Northeastern Coastal Zone	Connecticut Valley	Hampshire County, MA	23.8
Hampshire 2	Hay/pasture	Northeastern Coastal Zone	Lower Worcester Plateau/Eastern Connecticut Upland	Hampshire County, MA	33.2

[a] Bryce et al. (2010), Griffith et al. (2009).

[b] Point count locations were distributed across two separate field areas: 11.4 and 29.9 acres.

[c] Point count locations were distributed across three separate cattle pasture areas: 42.8, 68.7, and 95.8 acres.

[d] Point count locations were distributed across two separate field areas: 2.8 and 8.8 acres.

2.2 Field Sampling

Several field methods were used to collect bird and vegetation data at the PV solar sites and the paired reference sites. This section outlines how point-count surveys, vegetation measurements, and preliminary nest monitoring surveys were conducted to document bird use and the habitat conditions of each site during the breeding season.

2.2.1 Breeding Bird Point-count Surveys

Breeding bird point-count surveys were conducted during the peak breeding season in the Northeastern U.S., from early May to mid- or late July. Point count sampling locations at each solar site and paired reference site were randomly distributed within the delineated boundaries of the solar and paired reference sites using ArcMap 10.8.1.If needed, randomized points were adjusted to ensure each point was located ≥150 m from the nearest sampling location, thereby reducing nonindependence among samples and minimizing double-counting. Points were adjusted either by selecting another random point or shifting the points during the first field visit. To account for bird species and communities that may be using solar sites for foraging during the breeding season, random point counts were adjusted to ensure that the 50-m fixed radius of at least one (for sites <10 acres in size) or two (for sites >10 acres in size) points encompassed the edges of the solar facility and adjacent habitats, and one or two were "centered" within the solar facility when feasible. Birds were detected by sight and sound within a 50-m fixed radius plot over a 10-minute period, following standard avian sampling methods (Bibby et al. 2000; Ralph et al. 1995). Surveys were repeated two to three times over the course of the season, and the order of point visitations was systematically rotated between each round of surveys to avoid time-of-day bias.

For each point count location, the number of individual birds was recorded within the solar site or reference site boundary and in adjacent habitats on a map with ortho imagery of site features (e.g., solar arrays) within the 50-m point count radius (Figure 2). Detections (e.g., visual, auditory) of individual birds were recorded on the ortho maps, as was the distance to each individual bird using a laser rangefinder for visual detections or by estimating for auditory detections. Birds flying over sites during point counts but not actively using the area for foraging were recorded to provide qualitative information about birds in the surrounding landscapes. Aerial insectivores (swallows and swifts) traversing the point count radius in a low, indirect flight, implying foraging, were also recorded; however, "flyovers," defined as other bird species traversing the point count area without stopping, were excluded from the analyses. Site- and visit-specific information, including ambient noise experienced during the survey, using a scale from 1 (quiet or no noise) to 4 (constant noise), temperature (°C), cloud cover (percentage), and wind speed (Beaufort scale), was recorded to account for imperfect detection of birds (see Section 2.3.1.1). Counts were conducted from 0.5 hours before sunrise to approximately 5 hours after sunrise on mornings with no or minimal precipitation and little wind (e.g., Beaufort scale <4).

Figure 2. Ortho Imagery of 50-m Fixed-Radius Point Count Location in Photovoltaic Solar Site

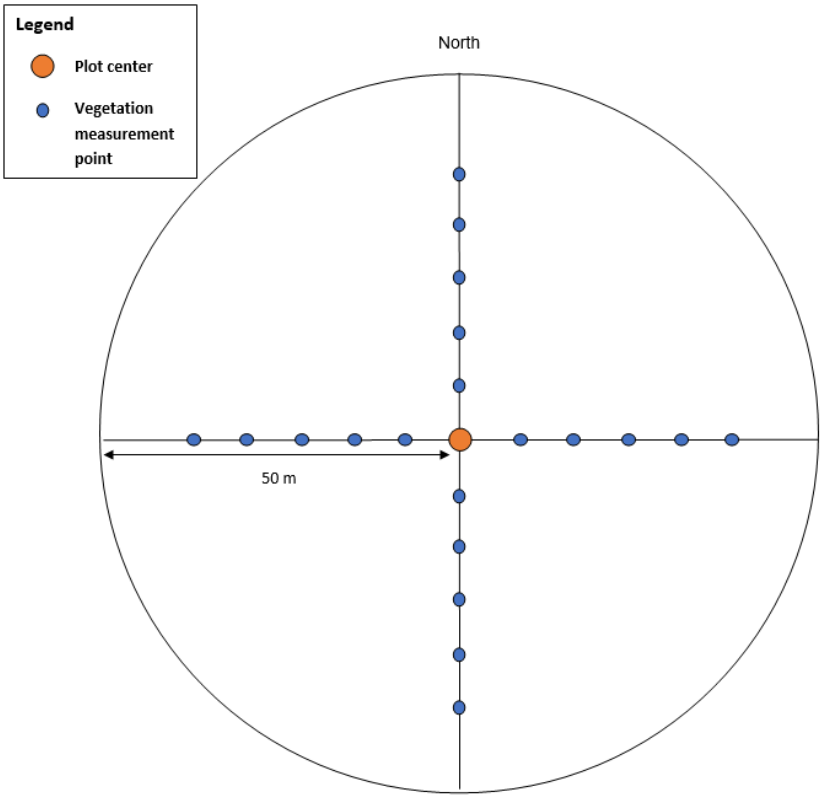
Ortho imagery showing the 50-m fixed-radius point count location used to map bird detections during the 2021 and 2022 field seasons.

2.2.2 Vegetation Sampling

This information was used to identify differences in vegetation and community composition at each point and to compare differences between the PV solar and paired reference sites. Vegetation sampling was conducted during each survey visit to the PV solar sites and most reference sites, after point counts were completed, to track short-term changes in vegetation structure resulting from management (e.g., mowing, harvesting) or vegetation growth. Within each 50-m radius point count plot, vegetation characteristics, including height, dominant species (i.e., tallest vegetation), and presence of invasive species, were recorded at multiple locations. Vegetation sampling generally followed point-intercept methods designed to assess changes in plant species or ground cover over time (Caratti 2006; Noon 1981). Vegetation measurements were taken at 3-m intervals along two orthogonal transects intersecting each survey point (Figure 3). Five measurements were recorded in each cardinal direction (north, east, south, and west) for a total of 20 measurements per 50-m point count plot at each PV solar and paired reference site. For point count locations near the edges of the fenced boundaries at PV solar sites, if the fence was encountered on a transect, observers randomly selected between two directions (i.e., left or right) to continue the transect and take vegetation measurements along the fenced boundary.

Figure 3. Orthogonal Transect Layout for Vegetation Sampling

Example of an orthogonal transect design used for vegetation sampling within a 50-m radius of a point count.



Vegetation measurements recorded at each 3-m interval in each cardinal direction consisted of counting the number of live vegetation contacts with the 3-m density pole and the height of the tallest contact, which was identified to species, where possible. These species data were then used to calculate the total percentage coverage of different ground cover classes (e.g., graminoid [grass and sedge], forb, shrub, bare ground) for each survey plot. Measurements at points beneath solar panels were taken with a 0.5–1 m density pole and recorded on data forms as taken beneath panels. If present, woody stems ≥0.5 m tall within a 1-m or 5-m subplot (depending on stem density) were also recorded in two size classes, “seedling” (≤2.5 cm) and “sapling” (>2.5–8 cm).

2.2.3 Locating and Monitoring Nests

During the first year of point count surveys in 2021, opportunistic observations of bird breeding and nesting behavior (e.g., nesting on or beneath facility structures) were recorded, and approximately 40 nests were incidentally encountered. As a result of opportunistic recording of bird breeding and nesting behaviors observed during point count surveys in 2021, nest surveys were conducted at a subset of the solar sites in 2022. Two PV solar facilities were selected based on the number of nests identified during initial nest location surveys conducted after point count and vegetation surveys on the first visit, and on the proximity between the two solar sites to facilitate access for monitoring nests every 2 to 5 days. Nest monitoring was not intended to be representative of all sites, but to provide some initial, qualitative insight into the number of nests that may be observed at PV solar sites during a single breeding season. Nests were also observed incidentally in 2022 at PV solar sites that were not selected for nest monitoring, and these nests are included primarily as a qualitative assessment.

Nest searching and monitoring protocols followed the recommendations of Martin and Geupel (1993). They consisted of systematically walking down the PV array rows to locate nests on the racking structures beneath PV modules and within vegetation on the ground during initial surveys in early and mid-May and on subsequent visits. Nest locations were marked with a GPS unit, and nest contents (e.g., number of eggs or chicks) were recorded to determine the laying or incubation stage and develop a monitoring schedule. During visits, nests were relocated from a distance and observed through binoculars to determine the status. Depending on the stage of the nest from the last visit and unless the nest was obscured by vegetation, the status would be determined to be “active” if an attending parent was on the nest. If no parents were present on the nest, the nest contents were checked and recorded as active if eggs or chicks were present, fledged if the nest was empty and the timing indicated that young had likely left the nest or young were observed near the nest, or failed if the nest was empty and there was evidence of depredation. Evidence of possible depredation or other causes of nest failure (e.g., abandonment) was then marked on the record for the nest. Care was also taken to visit nests as needed from different directions during each site visit, and time spent on the nests was minimized to reduce visual and scent trails that predators could follow to the nests.

2.3 Statistical Analyses

This section describes the analytical methods DNV used to evaluate bird occupancy, abundance, species richness, and vegetation structure at the PV solar sites in comparison with the paired reference sites. It also summarizes the approach DNV used to assess the preliminary nest monitoring data that was collected in the second year of the study.

2.3.1 Photovoltaic Solar and Paired Reference Sites Comparison

DNV used multiple modelling approaches to evaluate differences in bird communities and vegetation structure between the PV solar sites and their corresponding paired reference sites.

2.3.1.1 Occupancy Models

DNV used occupancy models to analyze the occupancy probabilities (ψ) of bird species in the solar sites in comparison to the paired reference sites (MacKenzie et al. 2017). Species that were detected during ≥10% of point count locations across the solar and reference sites were selected for occupancy analyses. Data analysis was conducted using the program R (R Core Team 2017), and DNV used the *occu* function in the *unmarked* R package (Fiske and Chandler 2011) for single species, single-season occupancy models (MacKenzie et al. 2022). The two years were modelled separately to meet the model assumptions of population closure (Fiske and Chandler 2011) and because sites were added in 2022. Detectability was modelled using covariates for observer ("obs"), ordinal date ("OD"), temperature ("Temp"), wind ("Wind"), noise ("Noise"), cloud cover ("Cloud"), and survey time (as hours since sunrise; "Hr.sun"). Each potential predictor variable for detection probability underwent individual modelling, and variables that produced a model with a lower Akaike's Information Criterion adjusted for small sample size (AICc) value relative to the intercept-only model were retained for further selection (Burnham and Anderson 2002). The predictor variables for detection were also checked for collinearity; when collinearity was observed between two variables, the more ecologically significant variable was selected for further analysis. For example, detection variables temperature and ordinal date exhibited collinearity; however, ordinal date is more likely to influence bird detection throughout the breeding season, and ordinal date was used in further modelling tests, dropping temperature. DNV standardized continuous predictor variables to have a mean of 0 and a standard deviation of 1.

Retained detection predictor variables were included in a new global model, and applied a backwards stepwise selection process (Hocking 1976) to remove non-significant variables ($P < 0.05$) systematically (Smetzer et al. 2014). Paired reference sites ("Pair") were set as the intercept or reference category in order to compare the differences between the solar sites ("Solar") and the paired controls. The site was included as a random effect. The difference in means between the solar and paired reference sites was considered significant if 95% confidence intervals (CIs) of the parameter estimates did not overlap zero. This process generated a list of candidate models, including a Null model, and the model with the lowest AICc score was selected as the top model. Goodness of fit (GOF) of each model was assessed using parametric bootstrapping to determine if our data fit within the expected distribution (Kéry and Royle 2020). For each species, DNV selected a model and then back-transformed linear combinations of coefficients to derive estimates of occupancy and detection probability.

2.3.1.2 Relative Abundance and Species Richness

DNV modelled the relative abundance of birds and species richness across the PV solar and the paired reference sites using generalized linear mixed models (GLMMs) with a negative binomial error distribution to account for overdispersion in count data. For abundance analyses, DNV used the maximum number of detections for all species across two to three visits at each point count location within a site. Abundance was then summed across species for each point count location (50-m radius; approximately 0.785 ha). Treatment (Solar vs. Pair) and year were included as two-level fixed effects, and site was included as a random effect. Species richness was calculated as the total number of unique species recorded at each site across all two to three survey visits and was modelled using the same GLMM framework. Model fit for total abundance and species richness was evaluated using simulation-based residual diagnostics using the *DHARMa* package for R, including tests for overdispersion, zero inflation, and residual uniformity, with visual comparisons of observed and predicted values. DNV ranked each model against a Null model based on differences in AICc (i.e., delta AICc between the Treatment and Null model ≥ 2). Model-estimated abundance and richness values were generated for PV solar and paired reference sites and compared between the two study years.

Bird species were assigned to broad habitat guilds based on their primary breeding and foraging habitat as described in species accounts in *Birds of the World* (Billerman et al. 2025), the Cornell Lab of Ornithology's *All about Birds*, and eBird species profiles (Table A-3). Species were classified according to dominant vegetation structure rather than land-use category, resulting in seven habitat guilds: forest, grassland, marsh, open woodland, scrub, urban, and water. The water habitat guild included species primarily associated with lakes, ponds, rivers, and streams, whereas "marsh" was defined as a type of wetland ecosystem dominated by grasses and other herbaceous vegetation. Species that use multiple habitat types were assigned to the habitat most strongly associated with breeding and foraging activities. For example, the alder flycatcher (*Empidonax alnorum*) was classified as a scrub due to its reliance on dense, woody thickets for nesting, despite its frequent occurrence near open areas (Billerman et al. 2025). Foraging guilds were also identified to evaluate whether PV solar sites offer opportunities for birds that exhibit different foraging strategies: carnivore, frugivore, granivore, insectivore, and omnivore. Interaction terms between treatment, habitat, and foraging guilds were included in models to assess the relationship between PV solar sites and the two guilds, and to identify any non-native species that may be disproportionately associated with PV solar, potentially due to the availability of anthropogenic nesting structures (e.g., PV racking systems).

2.3.1.3 Vegetation Models

To compare vegetation variables between the PV solar sites and paired reference sites, DNV calculated the mean of the 20 samples recorded for height and density (contacts) at each point count during each survey visit to retain some of the variability across survey visits. Other variables included the counts of woody stems classified into two categories (sapling and shrub). Differences in the sampled vegetation variables between PV solar sites and paired reference sites were assessed using GLMMs with Gamma or negative binomial distributions, depending on the data format (e.g., woody stems were count data and a negative binomial error distribution was used). Similar to the relative abundance and species richness GLMMs, each vegetation variable was modelled as the response with a fixed effect for treatment (Solar vs. Pair) and year, and a random effect for site. DNV ranked each model against a Null model based on differences in AICc. DNV did not predict estimates for these models but used the results to qualitatively infer relationships between the bird response metrics for occupancy, relative abundance, and species richness and the modelled results for vegetation.

2.3.2 Preliminary Nest Monitoring Analyses

Because nest monitoring was not included in the original objectives of this report, a qualitative assessment of the number of nests monitored and the approximate nest survival and success results was included. Other incidental nests and nesting behavior observed in 2021 and 2022 are included as qualitative information regarding the other PV solar sites that were not monitored in 2022.

3. Results

In 2021, point count surveys were conducted at nine solar facilities and nine paired reference sites from May 27 to July 25. Eighty-eight point count locations were surveyed in 2021, and the majority (70%) were visited three times, although some were visited only twice (30%). In 2022, four solar sites and four paired reference sites were added to the study, and surveys were conducted at all 13 solar sites and 13 paired reference sites from May 11 to July 26. A total of 126 point count locations were surveyed in 2022, and the majority (67%) were visited three times, although some were visited only twice (32%) or once (<1%) due to environmental or logistical challenges.

A total of 238 point count surveys were completed, and 4,760 vegetation measurements were collected in 2021. A total of 336 point count surveys were completed, and 6,720 vegetation measurements were collected in 2022. Table 3 summarizes the surveys, including the number of point count locations surveyed at each site and the dates of each survey visit in 2021 and 2022.

Table 3. Survey Visits at Solar and Paired References Sites in New York and Western Massachusetts for Surveys Conducted in 2021 and 2022

			2021 Survey Dates			2022 Survey Dates		
Site Reference Name	**Solar or Pair**	**No. of Point Count Locations Surveyed**	**Visit 1**	**Visit 2**	**Visit 3**	**Visit 1**	**Visit 2**	**Visit 3**
Albany 1	Solar	9	7/2/21	7/23/21	N/A	5/24/22[a]	7/1/22	7/19/22
Albany 1	Pair	9	6/24/21	7/20/21	N/A	6/11/22	7/6/22	7/20/22
Albany 2	Solar	4	7/2/21	7/23/21	N/A	5/24/22	6/30/22	7/18/22
Albany 2	Pair	4	6/25/21	7/21/21	N/A	6/4/22	6/30/32	7/18/22
Albany 3	Solar	5	5/30/21	6/18/21	7/13/21	5/22/22	7/3/22	7/23/22
Albany 3	Pair	5	7/10/21	7/15/21	7/18/21	5/19/22	6/29/22	7/17/22
Clinton 1	Solar	3	N/A	N/A	N/A	6/9/22	7/13/22	N/A
Clinton 1	Pair	3	N/A	N/A	N/A	7/14/22	7/15/22	N/A
Hampden 1	Solar	3	6/1/21	6/16/21	7/6/21	5/15/22	6/19/22	7/12/22
Hampden 1	Pair	3	5/28/21	6/16/21	7/6/21	5/16/22	6/21/22	7/11/22
Hampshire 1	Solar	4	5/27/21	6/18/21	7/7/21	5/12/22	6/21/22	7/15/22
Hampshire 1	Pair	4	6/2/21	6/19/21	7/6/21	5/14/22	6/23/22	7/8/22
Hampshire 2	Solar	4	5/27/21	6/18/21	7/7/21	5/11/22	6/20/22	7/16/22
Hampshire 2	Pair	4	6/2/21	6/19/21	7/6/21	5/14/22	6/22/22	7/9/22
Herkimer 1	Solar	4	5/28/21	6/16/21	7/10/21	5/20/22	6/24/22	7/13/22
Herkimer 1	Pair	4	7/19/21	7/24/21	7/25/21	5/21/22	6/25/22	7/14/22
Jefferson 1	Solar	4	N/A	N/A	N/A	6/1/22	7/12/22	N/A
Jefferson 1	Pair	4	N/A	N/A	N/A	7/11/22	7/12/22	N/A
Rensselaer 1	Solar	6	5/30/21	6/18/21	7/9/21	5/25/22	6/23/22	7/17/22
Rensselaer 1	Pair	6	6/17/21	6/23/21	7/11/21	6/3/22[b]	6/28/22	7/16/22[b]
Tompkins 1	Solar	6	N/A	N/A	N/A	5/28/22	6/26/22	N/A
Tompkins 1	Pair	6	N/A	N/A	N/A	7/8/22	7/10/22	N/A
Tompkins 2	Solar	6	N/A	N/A	N/A	5/29/22	6/28/22	N/A
Tompkins 2	Pair	6	N/A	N/A	N/A	7/9/22	7/22/22	N/A
Ulster 1	Solar	5	5/31/21	6/19/21	7/7/21	5/26/22	6/17/22	7/25/22
Ulster 1	Pair	5	6/19/21	6/20/21	7/8/21	5/26/22	6/17/22	7/26/22

[a] Surveys were not conducted at one point during this visit because a song sparrow nest was located less than 1 m from the point count location.

[b] Surveys were not conducted at one or two points on these visit dates because the area was fenced with grazing cattle.

Over the two years of the study, 3,084 birds representing 79 species across both the PV solar and paired reference sites were counted (Table A-1). Song sparrow (*Melospiza melodia*) was the most common, with 283 detections in 2021 and 416 in 2022 across both the PV solar and paired reference sites.

3.1 Photovoltaic Solar and Paired Reference Sites Comparison

This subsection presents the results of the comparative analyses between PV solar sites and their respective paired reference sites. It includes findings from occupancy modeling, abundance and richness estimates, and vegetation structure assessments conducted across the two study years.

3.1.1 Occupancy Models

Fourteen species fit the criteria for inclusion in our occupancy analyses (in descending order of total detections across both years; Table A-2):

- Song sparrow (*Melospiza melodia,* N = 699)
- Red-winged blackbird (*Agelaius phoeniceus*; N = 320)
- American robin (*Turdus migratorius*; N = 224)
- Barn swallow (*Hirundo rustica*; N = 203)
- House finch (*Haemorhous mexicanus*; N = 162)
- Common yellowthroat (*Geothlypis trichas*; N = 146)
- American goldfinch (*Spinus tristis*; N = 114)
- Gray catbird (*Dumetella carolinensis*; N = 102)
- Savannah sparrow (*Passerculus sandwichensis*; N = 77)
- Bobolink (*Dolichonyx oryzivorus*; N = 115)
- Tree swallow (*Tachycineta bicolor*; N = 58)
- Yellow warbler (*Setophaga petechia*; N = 57)
- Field sparrow (*Spizella pusilla*; N = 56)
- Eastern phoebe (*Sayornis phoebe*; N = 27)

Detection probability. After running detection variables individually and back-transforming with the global model, it was determined that the detection predictor variables for wind and noise were not significant ($P > 0.05$) for most bird species in 2021, and most species models had a single predictor variable of observer (“obs”) or a combination of observer and ordinal date (“OD”). In 2022, selected detection-predictor variables for each model varied more widely, and several species models included combinations of observer, ordinal date, and survey time (“Hr.sun”).

Predicted occupancy results. For a subset of selected species for which DNV encountered model-convergence issues with the *occu* function, likely due to low detection frequencies at PV solar or paired sites despite otherwise meeting the selection criteria, DNV instead compared species occurrence (presence or absence). DNV modelled occurrence at each point count location using GLMMs with a binomial error distribution and a logit link, including site as a random effect. This approach estimates the probability of occurrence at a point (μ), which represents detection at least once across survey visits and does not explicitly account for imperfect detection. Therefore, the results for these species are interpreted as estimated patterns of occurrence rather than occupancy.

Predicted occupancy and occurrence probabilities for each species with model statistics (z-statistic and *p*-value), the standard error (SE), and 95% CIs of the predicted probabilities are included in Table 4. Occupancy probabilities were not predicted for species for which the Null model was the best fit during model selection. GOF tests indicated no significant lack of fit due to overdispersion (P = 0.95).

The predicted occupancy or occurrence probabilities for 14 bird species varied between the solar and paired reference sites across the 2 years. In 2021, the occupancy models for common yellowthroat and song sparrow showed significant differences between the solar and paired reference sites with *p*-values of 0.0437 and 0.0004, respectively. Song sparrow predicted occupancy in the solar sites was higher (0.97) than in the paired reference sites (0.49). At the same time, predicted occupancy for common yellowthroat was higher in the paired reference sites (0.52) than in the solar sites (0.22). All other species did not show a significant difference between solar and pair, but the random effect of site indicated high site variability. Additionally, the *p*-value for the Savannah sparrow was marginally above the 0.05 significance threshold at 0.0533 and determined to be statistically insignificant.

In 2022, occupancy models for six species showed statistically significant differences in occupancy between the solar and paired reference sites. American robin occupancy was significantly higher at solar sites (0.77) than at reference sites (0.32; *p* = 0.0017). Similarly, song sparrow modelled occupancy was higher at solar sites (0.97) compared to the reference sites (0.63; *p* = 0.0002), and tree swallow occupancy probability at solar sites was 0.96 compared to 0.04 at reference sites (*p* = 0.0000041). In contrast, bobolink showed much lower predicted occupancy at solar sites (0.02) than reference sites (0.37; *p* = 0.0003), as did Savannah sparrow with 0.01 at solar compared to 0.16 at reference sites (*p* = 0.0040) and common yellowthroat with 0.20 at solar compared to 0.48 at reference sites (*p* = 0.0175).

Most other species showed no significant differences, although some showed consistent directional trends across years. Notably, species such as the house finch showed higher modelled occupancy at solar sites in both years, although this was statistically significant only for the house finch in 2021 (*p* = 0.0071). Several estimates, particularly those based on smaller sample sizes, exhibited wide CIs, suggesting high uncertainty.

Table 4. Predicted Occupancy (ψ) Probabilities by Species, Site Type, and Year

Model-predicted occupancy probabilities (ψ) are shown for 14 bird species in solar and paired reference sites by study year. For three species, occurrence (presence–absence) probabilities (μ) were estimated using GLMMs due to convergence issues with occupancy models. SE are given in parentheses, 95% CI in brackets, along with z-statistics, *p*-values, and total detections for each species (n). Significant p-values are shown in boldface.

	2021					2022				
Species	**Solar (SE) (95% CI)**	**Paired Reference (SE) (95% CI)**	**z**	***p***	**n**	**Solar (95% CI)**	**Paired Reference (95% CI)**	**z**	***p***	**n[a]**
American goldfinch	0.14 (0.04)[b] [0.04–0.07]	0.10 (0.03)[b] [0.03–0.04]	0.913[b]	0.361[b]	52	0.52 (0.19) [0.19–0.83]	0.35 (0.14) [0.14–0.65]	0.99	0.3204	50
American robin	0.95 (0.15) [0.05–0.99]	0.40 (0.10) [0.23–0.59]	1.13	0.2598	79	0.77 (0.10) [0.53–0.91]	0.32 (0.08) [0.18–0.49]	3.14	**0.0017**	124
Barn swallow	0.32 (0.20) [0.07–0.75]	0.52 (0.22) [0.16–0.86]	-1.10	0.2722	112	0.33 (0.19) [0.08–0.73)	0.24 (0.15) [0.06–0.62]	0.56	0.5727	91
Bobolink	0.01 (0.02) [0.00–0.25]	0.13 (0.11) [0.02–0.49]	-1.80	0.0719	67	0.02 (0.02) [0.00–0.12]	0.37 (0.12) [0.18–0.62]	-3.63	**0.0003**	42
Common yellowthroat	0.22 (0.12) [0.07–0.53]	0.52 (0.17) [0.23–0.80]	-2.02	**0.0437**	68	0.20 (0.09) [0.08–0.43]	0.48 (0.14) [0.24–0.73]	-2.38	**0.0175**	77
Eastern phoebe	0.78 (0.66) [0.00–0.99]	0.30 (0.28) [0.03–0.86]	0.72	0.4717	15	0.03 (0.02)[b] [0.00–0.06]	0.01 (0.01)[b] [0.00–0.02]	1.84[c]	0.0655[b]	11
Field sparrow	0.03 (0.04) [0.00–0.35]	0.10 (0.11) [0.01–0.57]	-1.44	0.1497	30	0.03 (0.02)[c] [0.00–0.08]	0.03 (0.02)[c] [0.00–0.07]	0.36 [c]	0.723[c]	26
Gray catbird	0.41 (0.15) [0.18- 0.70]	0.29 (0.11) [0.12–0.55]	0.80	0.4222	47	—[c]	—[c]	—[c]	—[c]	51
House finch	0.42 (0.16) [0.16–0.72]	0.03 (0.03) [0.00–0.22]	2.69	**0.0071**	54	0.18 (0.06)[b] [0.06–0.31]	0.0001 (0.001)[b] [0.00–0.0000006]	0.002[b]	0.998[b]	99
Red-winged blackbird	0.40 (0.11) [0.22–0.62]	0.47 (0.12) [0.25–0.70]	-0.51	0.6086	110	0.42 (0.14) [0.20–0.68]	0.69 (0.14) [0.38–0.89]	-1.79	0.0742	145

Table 4. (continued)

		2021					2022			
Species	**Solar (SE) (95% CI)**	**Paired Reference (SE) (95% CI)**	**z**	***p***	**n**	**Solar (95% CI)**	**Paired Reference (95% CI)**	**z**	***p***	**n^a**
Savannah sparrow	0.05 (0.04) [0.01–0.22]	0.22 (0.09) [0.09–0.44]	-1.93	0.0533	26	0.01 (0.01) [0.00–0.17]	0.16 (0.16) [0.02–0.65]	-2.88	**0.0040**	51
Song sparrow	0.97 (0.03) [0.83–0.99]	0.49 (0.13) [0.26–0.72]	3.57	**0.0004**	270	0.97 (0.02) [0.87–0.99]	0.63 (0.09) [0.44–0.78]	3.67	**0.0002**	390
Tree swallow	0.03 (0.02)^b [0.00–0.06]	0.03 (0.02)^b [0.00–0.06]	-0.012^b	0.99^b	15	0.96 (0.004) [0.95–0.97]	0.04 (0.07) [0.00–0.53]	4.12	**0.00004**	43
Yellow warbler	0.20 (0.18) [0.02–0.70]	0.12 (0.13) [0.01–0.62]	0.45	0.6510	26	0.26 (0.17) [0.06–0.66]	0.66 (0.33) [0.10–0.97]	-1.21	0.2246	30

[a] Total detections during surveys are not reflected in the total number of detections used in occupancy analyses because 3–4 survey points were removed from analyses as they were only surveyed once during the study year.

[b] Occupancy models returned NaNs. This may have been due to the few detections per species at either solar or paired reference sites. However, they otherwise met the inclusion criteria for analyses (≥ 10% of all point counts). Therefore, these results represent occurrence (μ) predictions that were obtained from running a GLMM for these species.

[c] Occupancy probability was not estimated for this species because the backward stepwise selection process identified the Null as the top model, indicating that the difference between solar and paired controls is not a significant predictor for the gray catbird occupancy probability for the surveys conducted in 2022.

3.1.2 Relative Abundance and Species Richness

Mean total bird abundance per point count was highest in solar for 12 species compared to the paired reference sites, where mean abundance was highest for 14 species. Figure 4 shows a selection of 25 species to illustrate differences in abundance means between PV solar sites and paired reference sites and between years. These illustrative abundance means are comparable to the occupancy results for the most abundant species in the PV solar sites, including song sparrow, American robin, house finch, and red-winged blackbird.

Mean predicted abundance was slightly higher at PV solar sites than at paired reference sites in both survey years (Figure 5), but this difference was not statistically supported. In 2021, predicted mean abundance was 10.97 birds per point (SE = 0.98) at solar sites and 9.51 birds per point (SE = 0.88) at paired reference sites. In 2022, predicted abundance was 10.43 birds per point (SE = 0.86) at solar sites and 9.04 birds per point (SE = 0.76) at paired reference sites. The effect of treatment (Solar vs. Pair) was positive and significant ($p = 0.05$). No evidence of a year effect on total abundance was observed, with predicted values similar between 2021 and 2022 ($p = 0.52$). Site-level variation accounted for a small proportion of the total variance (random-effect SD = 0.19).

Similar to mean predicted abundance, the mean predicted species richness per point count was slightly higher at PV solar sites than at paired reference sites in both survey years (Figure 6), but this difference was small and not statistically significant ($p = 0.23$). Species richness did not differ between years ($p = 0.96$). As with total abundance, site-level variability contributed modestly to overall variation in richness (random-effect SD = 0.14). These findings provide limited support for differences in species richness per point count between PV solar and paired reference sites.

Figure 4. Mean Bird Abundance by Species and Treatment

Bars show the descriptive mean abundance per point count (50-m fixed radius) for 25 individual species recorded at PV solar sites and paired reference sites. Means were averaged across survey points within sites and across sites within each treatment. For each species, results are presented for two survey years, with Year 1 (2021) on the left and Year 2 (2022) on the right of each panel. The orange bars indicate paired reference sites, and the blue bars indicate PV solar sites. Numeric values above the bars denote mean abundance per point.

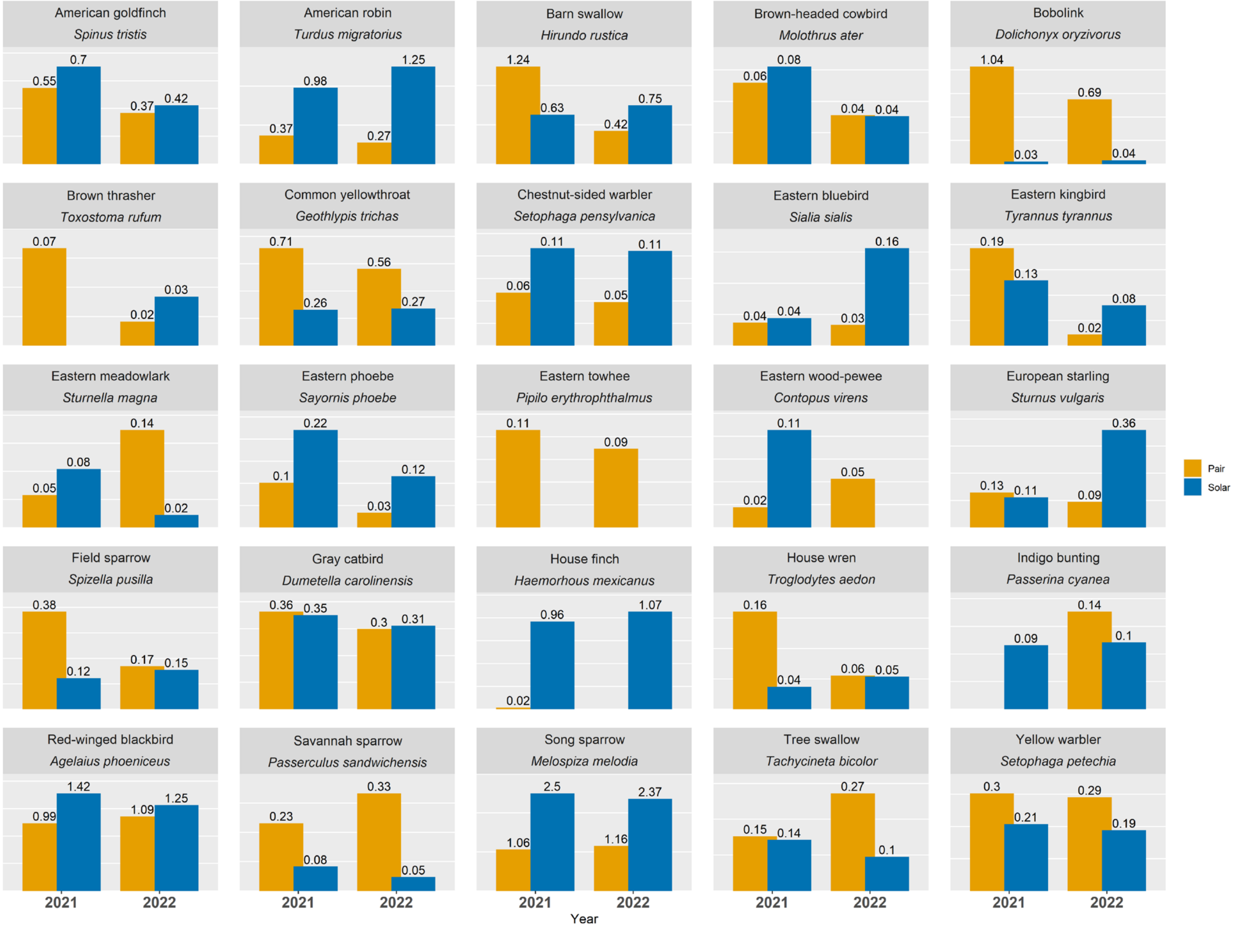


Figure 5. Model-predicted Total Bird Abundance by Site and Year

The bars show model-predicted total bird abundance per point count (± SE) for PV solar sites and paired reference sites in 2021 and 2022. Total predicted bird abundance for the paired reference sites is on the left of the figure and PV solar sites are on the right of the figure. The dark bars represent the total predicted bird abundance in 2021, and the lighter bars with the dashed outline represent predicted bird abundance in 2022.

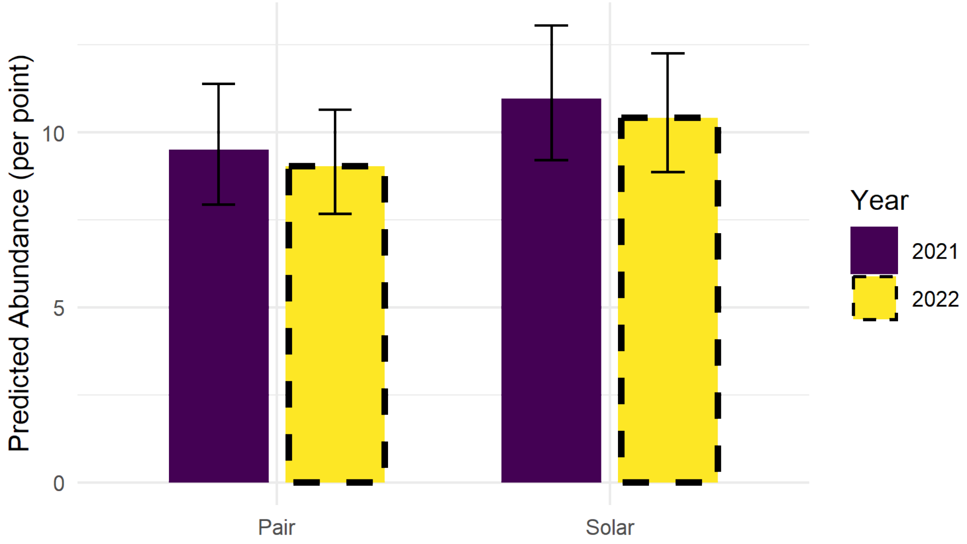
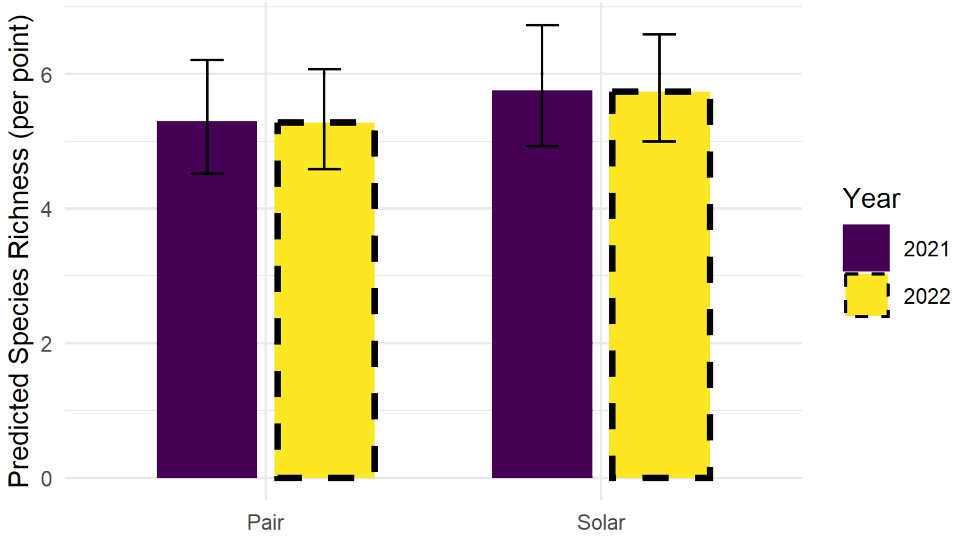


Figure 6. Model-predicted Species Richness by Site and Year

The bars show model-predicted species richness per point count (± SE) for PV solar sites and paired reference sites in 2021 and 2022. Total predicted species richness for the paired reference sites is on the left of the figure and PV solar sites are on the right of the figure. The dark bars represent predicted species richness in 2021, and the lighter bars with the dashed outline represent the predicted species richness in 2022.



Bird abundance varied significantly among habitat guilds and differed between solar and paired reference sites (Table A-4). Relative to forest reference sites, abundance at reference sites was significantly higher for grassland, marsh, open woodland, scrub, and water-associated guilds. Forest-associated species were significantly less abundant at solar sites compared to paired references. However, significant habitat-by-solar interactions indicated that marsh (*$p = 0.002$*), open woodland ($p < 0.001$), and urban-associated species ($p < 0.001$) exhibited higher abundance at solar sites relative to reference sites, with the strongest positive response observed for the urban guild. Grassland, scrub, and water-associated species showed no significant difference between solar and reference sites. Year had no detectable effect on abundance. While dispersion tests did not indicate overdispersion, residual diagnostics suggested mild departures from model assumptions, and the results are therefore interpreted as qualitative patterns of bird responses across different habitat guilds to PV solar sites.

Bird abundance differed strongly among foraging guilds but showed no evidence of guild-specific responses to solar development. In the negative binomial mixed-effects model, carnivorous species at paired reference sites served as the intercept. Relative to carnivores, granivorous, insectivorous, and omnivorous species exhibited significantly higher abundances, whereas frugivores did not differ significantly from the reference guild (Table A-5). PV solar sites alone did not significantly affect abundance for carnivorous species, nor did they interact significantly with any foraging guild. All solar and foraging guild interaction terms were not significant, indicating that differences in abundance among foraging guilds were consistent between solar and paired reference sites. Year had no detectable effect on abundance. Overall, these results suggest that foraging guild composition influences bird abundance, but the PV solar does not differentially affect abundance among foraging guilds.

3.1.3 Vegetation Models

Mean vegetation height is modelled using a GLMM with a Gamma error distribution. Model results varied by year but not by treatment. Mean height was significantly lower in 2022 relative to 2021 ($p = 0.017$), indicating an overall decline in vegetation in the mean vegetation height across sites in the second sampling year. Mean height did not differ significantly between PV solar and paired reference sites ($p = 0.154$). Variation among sites as a random effect was moderate, suggesting consistent site-level differences in vegetation structure across treatments.

Mean vegetation contacts differed significantly between treatments and years. Vegetation density was higher at PV solar sites than paired reference sites ($p = 0.048$), indicating denser vegetation structure within solar arrays. Mean contacts were also significantly lower in 2022 than in 2021 ($p < 0.001$), reflecting interannual variability in vegetation density. Variance among sites as a random effect was similar to the variance observed for vegetation height.

Seedling and sapling abundance were modelled using a negative binomial GLMM to account for overdispersed count data. Both sapling and seedling abundances differed strongly between treatments and years. The mean seedling abundance per point count and the mean sapling abundance per point count were significantly lower at PV solar sites than paired reference sites (both exhibited a $P < 0.001$). These results indicate reduced woody regeneration within solar facilities, likely due to regular maintenance during the breeding bird and the spring and summer growing seasons. Seedling abundance was significantly lower in 2022 compared to 2021 ($P = 0.014$). In contrast, sapling abundance was higher in 2022 than in 2021 ($p = 0.045$). Substantial site-level variance indicated strong heterogeneity in both seedling and sapling abundance across the study sites.

3.2 Preliminary Nest Monitoring

Prior to initiating nest monitoring in 2022, DNV incidentally observed 30 avian nests across the 9 PV solar sites surveyed in 2021. The majority of nests were observed on the racking structures of the PV arrays; however, several song sparrow nests and one field sparrow nest were also found within the vegetation on the PV solar sites.

The two sites selected for nest searching and monitoring in 2022 were Hampshire 1 and Hampshire 2, both in Hampshire County in Western Massachusetts. The two sites were located within 1 km of each other, and both could be visited during a single nest-check, which was completed every 3 to 5 days. Sixty-five nests were located and monitored at Hampshire 1, and 10 nests were located and monitored at Hampshire 2. These numbers include multiple broods for some bird species (e.g., house finch) and second nesting attempts after the first nest failed. Most nests were observed on the racking structures, accounting for 73% of the total nests monitored across the two sites. House finch and American robin were the only two species observed nesting on the structures. Song sparrows were the only species observed nesting in vegetation on the ground, between solar panel arrays, or on the edges of the facilities within the fenced boundaries. Savannah sparrows exhibited nesting behavior in Hampshire 2, but no nests were found during the monitoring. Nest fate was classified conservatively based on field observations. Nests were considered successful only when fledging was directly observed or explicitly documented. Nests were classified as failed when failure was clearly recorded, such as when observed or when evidence of depredation or nest abandonment was present. All other outcomes, including missed visits, lack of evidence of successful fledging, or other uncertainty regarding nest fate, were conservatively categorized as indeterminate, and success was not inferred. Across both sites, approximately 30% of the nests monitored successfully fledged young, 16 % failed, and the remaining 54% did not have a fate determination, primarily due to a lack of evidence of successful fledging or predation-related nest failure.

Fifty avian nests were incidentally observed across the remaining 11 PV solar sites surveyed in 2022. Similar species were incidentally observed nesting on the structures. They included house finch, American robin, eastern phoebe, European starling (*Sturnus vulgaris*), house wren (*Troglodytes aedon)*, and eastern bluebird (*Sialia sialis*) (Klehr et al. 2024). Other species, such as the Savannah sparrow, common yellowthroat, wild turkey, and red-winged blackbird, exhibited nesting behaviors at several sites in 2022, but nesting was not confirmed for these species.

4. Discussion

The study, completed over two breeding seasons in 2021 and 2022, used standard point count methodologies to assess bird communities in PV solar energy facilities and paired controls, and broadly provides evidence that breeding bird communities at PV solar facilities in New York and Western Massachusetts differ from paired reference sites in agricultural, forested, and shrub-scrub systems. Long-term declines of grassland birds, shrubland birds, and aerial insectivores across eastern North America have been strongly linked to agricultural intensification, including early and frequent hay harvests, increased mowing frequency, chemical inputs, and landscape homogenization (Morgan and Burger 2008; Stanton et al. 2018). Intensive agricultural management has been shown to directly reduce nesting success through nest destruction and indirectly reduce reproductive output through altered food availability and increased predation risk (van Vlieta et al. 2020). Growing evidence suggests that PV solar energy developments sited in agricultural landscapes or previously disturbed lands may provide nesting and foraging habitat (Jarčuška et al. 2024; Copping et al. 2025; Walston et al. 2025).

The results generally align with recent studies showing that PV solar facilities established on former agricultural lands often support bird communities. The occupancy modelling results revealed pronounced species-specific responses to PV solar facilities (Table 4), in which the predicted occupancy probability (ψ) or occurrence (μ; for species with model convergence issues) for 5 of the 14 species was higher at PV solar sites across years, including song sparrow, American robin, house finch, eastern phoebe, and American goldfinch. Four species exhibited higher occupancy probabilities in one year but lower in another (barn swallow, gray catbird, tree swallow, yellow warbler). In contrast, predicted occupancy probability at PV solar sites was lower for bobolink, Savannah sparrow, common yellowthroat, red-winged blackbird, and field sparrow across both survey years. In general, species with higher occupancy probability are considered "generalist" species. However, they are also more common in open woodland habitats with a heterogeneous mix of forest edge and open fields or grasslands. Alternatively, species considered "specialists" and primarily associated with grasslands or shrubland habitats had lower predicted occupancy probabilities. The comparison of mean abundance per point count for 25 species also revealed similar patterns (Figure 4), but those results were not modelled and were completed for illustrative purposes. This also aligns with evidence that some grassland obligates require large open fields with minimal vertical structure and may avoid landscapes fragmented by PV solar panel rows and fencing (van Vlieta et al. 2020).

In comparison to the results presented by Walston et al. (2025), in which 10 out of 13 grassland bird species had greater predicted occupancy probabilities on PV sites than agricultural control sites, the occupancy modelling results show the opposite for the majority of grassland bird species that were detected. Importantly, however, paired reference sites in this study were not uniform control sites in row crop agricultural systems as in Walston et al., but instead included a range of agricultural and early-successional habitats, including hayfields, pasture, old fields, and scrub-shrub edges. Additionally, some of these sites were actively managed in bird-friendly ways (e.g., delayed mowing), while others were harvested or grazed throughout the breeding seasons. Although this variability was not accounted for in the models, it likely contributed to greater grassland bird occupancy probabilities in paired controls and underscores that the simple treatment level alone is insufficient to predict avian communities without consideration of land use and management intensity.

The relative avian abundance and species richness results showed that mean predicted abundance and mean predicted richness were slightly higher at PV solar sites than at paired controls in both survey years, but neither response was statistically significant. These results may also be overestimated by some species that exhibited high abundance at PV solar sites; however, the correction for maximum counts across all site visits accounted for this potential discrepancy. Additionally, an offset for the number of point counts per site did not show a significant effect when it was added to the models and performed worse than the selected model that produced the predicted abundances. Site variability was likely a factor for these results as well.

4.1 Bird Response to Vegetation

The study’s findings indicated that vegetation structure differed markedly between PV solar and paired reference sites, providing important qualitative context for the modelled bird responses. Although mean vegetation height did not differ significantly between treatments, vegetation was denser at the PV solar sites compared to the paired controls, as indicated by higher mean vegetation contacts. In contrast, woody stem regeneration was consistently lower at the PV solar sites, with both seedling and sapling abundance significantly lower relative to the paired reference sites. The strong suppression of saplings, in particular, suggests that while early woody establishment may occur sporadically within PV solar facilities, management and other conditions likely limit the growth and progression of the woody stems into larger size classes.

These vegetation patterns likely influence bird use of PV solar sites through multiple mechanisms, potentially in opposing ways. Increased ground-layer density may enhance foraging opportunities and cover for species associated with open or early-successional habitats, including granivores and ground- or shrub-foraging insectivores. At the same time, reduced woody regeneration and the scarcity of saplings likely limit structural complexity and vertical stratification, constraining habitat suitability for forest-associated and shrub-nesting species that depend on woody vegetation for foraging, nesting, or predator avoidance.

The divergence between dense herbaceous cover and suppressed woody growth suggests that PV solar sites function as structurally simplified habitats that may favor open-habitat or disturbance-tolerant bird species while limiting the establishment of species associated with later successional stages. This interpretation is consistent with observed differences in bird abundance and PV solar site–habitat guild interactions. It highlights the possibility that vegetation management is a key driver of avian habitat use within solar facilities. Management practices that influence ground cover density and woody encroachment may therefore play a critical role in mediating the ecological value of PV solar sites for bird communities.

These results also reinforce the importance of vegetation structure in shaping specific bird responses. The structural variability in height, density, and presence of woody stems likely contributed to the presence of shrubland and open woodland or edge-associated species and some grassland-associated species, a pattern also reported from European and Midwestern U.S. solar studies (Copping et al. 2025; Walston et al. 2025).

4.2 Habitat and Foraging Guild Responses

Habitat guild analyses further support the interpretation that vegetation composition and structure on PV solar sites may influence bird responses (Table A-4). Urban-associated, open woodland, and marsh guilds exhibited significantly higher abundance at solar sites relative to reference sites, whereas forest-associated species were less abundant at solar facilities. Grassland and scrub guilds showed no significant differences between treatments. This pattern aligns closely with Copping et al. (2025), who found that solar farms managed with mixed vegetation structure supported higher abundances of edge-tolerant and generalist species than those managed uniformly. Notably, mean vegetation height did not differ between solar and reference sites, but vegetation density was higher at solar sites. Dense herbaceous cover without tall woody growth may benefit species such as song sparrows and red-winged blackbirds while simultaneously discouraging species that require tall grass (bobolinks) or very short, sparse cover (some grassland specialists). These nuanced vegetation effects help illustrate potential reasons why some grassland species responded positively while others did not.

Unlike habitat guilds, foraging guilds did not exhibit differential responses to solar development (Table A-5). Abundance differed strongly among foraging guilds overall, but PV solar sites did not interact significantly with any foraging guild. This contrasts somewhat with findings from Walston et al. (2025), where grassland insectivores showed strong positive responses to ecovoltaic sites, potentially due to increased insect abundance.

The absence of a foraging guild response in this study may reflect the fact that paired reference sites included a mix of agricultural and seminatural habitats rather than exclusively row-crop fields. Additionally, insect abundance was not measured directly, limiting inference about prey mechanisms. Nevertheless, frequent observations of barn swallows and tree swallows foraging over panel arrays suggest that solar facilities may still function as important foraging habitat for aerial insectivores, consistent with other solar studies (Walston et al. 2025).

4.3 Nesting Behavior

Nest monitoring and incidental nest observations provide additional context for interpreting occupancy and abundance patterns. Across sites, the majority of nests were located on PV racking structures and were dominated by generalist species such as house finch and American robin. Song sparrow was the only species confirmed to be nesting within ground vegetation at solar sites, while the Savannah sparrow exhibited nesting behavior, but no nests were located.

This pattern is consistent with observations reported by Walston et al. (2025) and other studies documenting frequent use of solar infrastructure for nesting by habitat generalists, while species that nest on the ground and in herbaceous or woody vegetation may nest within vegetation beneath and between PV panel arrays when conditions permit. Approximately 30% of monitored nests were confirmed successful, although over half were classified as indeterminate, underscoring the challenges of assessing reproductive success at operational solar facilities.

The use of infrastructure for nesting may also partially explain the higher occupancy of some species at solar sites. However, it also raises questions about long-term fitness consequences, including exposure to maintenance activities or increased predation risk. As emphasized by Walston et al. (2025), higher occupancy does not necessarily equate to population-level benefits.

4.4 Limitations and Future Research Needs

Several limitations should be considered when interpreting these findings. First, surveys were conducted only during the breeding season; seasonal patterns of habitat use during migration or winter remain unknown. Second, some detections occurred outside fenced PV panel arrays but within the 50-m fixed-radius plots, potentially inflating abundance or richness estimates for both solar and reference sites. However, at broader spatial scales, such edge use is likely functionally relevant, particularly in fragmented agricultural landscapes. Third, management variables such as mowing frequency, grazing intensity, and facility age were not explicitly included in statistical models. These factors likely influence vegetation establishment and bird recolonization and should be considered in future studies.

Finally, while this study documented avian use, it did not directly measure reproductive success for most species. Evidence from agricultural systems indicates that habitat use does not always translate to demographic benefits, particularly when nests are vulnerable to disturbance or predation (van Vlieta et al. 2020). Integrating nest monitoring, passive acoustic monitoring, or automated wildlife cameras would strengthen future assessments, particularly at larger facilities where observer coverage is limited.

5. Management Implications

From a management perspective, the limited differences in abundance and richness, combined with species-specific occupancy and occurrence from the results, suggest that PV solar developments can be compatible with maintaining local bird communities when sited and managed with ecological considerations in mind. Five key points emerged from this study and may be considered for evaluating, developing, and managing PV solar energy developments.

1. **Informed siting and vegetation management:** Solar development on former agricultural fields, especially those previously subject to intensive management, may provide net benefits for birds. If vegetation is managed such that minimal mowing or other management strategies are implemented through the breeding bird season, local bird populations may use the site for nesting and foraging. Species-specific considerations, including those for grassland obligates sensitive to vegetation height and mowing timing, could be incorporated into vegetation management plans.
2. **Facility size and layout:** This study was completed with the use of predominantly community-scale solar facilities with a nameplate capacity of less than 10 MW. Larger facilities with more continuous "seas of panels" may function differently from smaller sites, and understanding how panel density, spacing, and fence placement affect habitat use will be important for optimizing outcomes for area-sensitive species.
3. **Adaptive monitoring approaches:** This study was limited to the breeding bird season, which is a valid method for the statistics and results presented herein. However, passive acoustic recorders and wildlife cameras offer promising tools for monitoring large or complex sites, reducing observer bias and enabling longer-term, multiseason assessments, as demonstrated in recent ecovoltaic research (Walston et al. 2025).
4. **Integration with broader landscape planning:** Solar facilities should be evaluated as components of larger landscapes rather than isolated features. When embedded within heterogeneous landscapes or paired with bird-friendly practices, solar facilities may contribute to regional conservation goals.
5. **Vegetation composition and seed mixes:** The predominance of native and naturalized species at the PV solar sites included in this study suggests that commonly used commercial seed mixes can support functional habitat. Evaluation of seed mix composition before reseeding, along with monitoring and management of long-term vegetation dynamics, can help establish a diverse vegetation community within a solar site that will provide ecological benefits to birds and other animals.

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Appendix A. Tables

This appendix contains supplementary tables that provide detailed data supporting the analyses presented in the main report. These tables include species observations, habitat and foraging guild classifications, and model outputs, which are referenced in the results and discussion sections. They are intended to give readers access to the full underlying datasets that have informed the findings of this study.

Table A-1. Annual Species Observations at Solar and Paired Reference Site

For each species and survey year, the table reports the number of observations (Number Obs) at solar and paired reference sites. Fledglings, juvenile birds, and flyovers were excluded from counts. Breeding Bird Survey (BBS) population trends (Sauer et al. 2020) for Massachusetts and New York are provided. The 14 species included in abundance and habitat analyses are highlighted in light blue. Detections not confirmed to species level and excluded from analyses are highlighted in gray.

Species Common Name (AOU Code)	Species Scientific Name	Survey Year	Solar or Pair	Number Obs	BBS Trend
Alder flycatcher (ALFL)	*Empidonax alnorum*	2021	Solar	1	2.72 (MA)1 0.42 (NY)1
Alder flycatcher (ALFL)	*Empidonax alnorum*	2021	Pair	1	2.72 (MA)1 0.42 (NY)1
Alder flycatcher (ALFL)	*Empidonax alnorum*	2022	Solar	0	2.72 (MA)1 0.42 (NY)1
Alder flycatcher (ALFL)	*Empidonax alnorum*	2022	Pair	3	2.72 (MA)1 0.42 (NY)1
American crow (AMCR)	*Corvus brachyrhynchos*	2021	Solar	0	-0.03 (MA) 0.03 (NY)
American crow (AMCR)	*Corvus brachyrhynchos*	2021	Pair	0	-0.03 (MA) 0.03 (NY)
American crow (AMCR)	*Corvus brachyrhynchos*	2022	Solar	0	-0.03 (MA) 0.03 (NY)
American crow (AMCR)	*Corvus brachyrhynchos*	2022	Pair	1	-0.03 (MA) 0.03 (NY)

Table A-1. (continued)

Species Common Name (AOU Code)	Species Scientific Name	Survey Year	Solar or Pair	Number Obs	BBS Trend
American goldfinch (AMGO)	*Spinus tristis*	2021	Solar	34	0.93 (MA) -1.04 (NY)
American goldfinch (AMGO)	*Spinus tristis*	2021	Pair	27	0.93 (MA) -1.04 (NY)
American goldfinch (AMGO)	*Spinus tristis*	2022	Solar	32	0.93 (MA) -1.04 (NY)
American goldfinch (AMGO)	*Spinus tristis*	2022	Pair	21	0.93 (MA) -1.04 (NY)
American kestrel (AMKE)	*Falco sparverius*	2021	Solar	3	-4.93 (MA) -1.99 (NY)
American kestrel (AMKE)	*Falco sparverius*	2021	Pair	0	-4.93 (MA) -1.99 (NY)
American kestrel (AMKE)	*Falco sparverius*	2022	Solar	0	-4.93 (MA) -1.99 (NY)
American kestrel (AMKE)	*Falco sparverius*	2022	Pair	0	-4.93 (MA) -1.99 (NY)
American redstart (AMRE)	*Setophaga ruticilla*	2021	Solar	0	NA
American redstart (AMRE)	*Setophaga ruticilla*	2021	Pair	2	NA
American redstart (AMRE)	*Setophaga ruticilla*	2022	Solar	0	NA
American redstart (AMRE)	*Setophaga ruticilla*	2022	Pair	1	NA
American robin (AMRO)	*Turdus migratorius*	2021	Solar	67	-0.84 (MA) -0.61 (NY)
American robin (AMRO)	*Turdus migratorius*	2021	Pair	20	-0.84 (MA) -0.61 (NY)
American robin (AMRO)	*Turdus migratorius*	2022	Solar	114	-0.84 (MA) -0.61 (NY)

Table A-1. (continued)

Species Common Name (AOU Code)	Species Scientific Name	Survey Year	Solar or Pair	Number Obs	BBS Trend
American robin (AMRO)	*Turdus migratorius*	2022	Pair	23	-0.84 (MA) -0.61 (NY)
Baltimore oriole (BAOR)	*Icterus galbula*	2021	Solar	2	-2.1 (MA) -1.54 (NY)
Baltimore oriole (BAOR)	*Icterus galbula*	2021	Pair	1	-2.1 (MA) -1.54 (NY)
Baltimore oriole (BAOR)	*Icterus galbula*	2022	Solar	0	-2.1 (MA) -1.54 (NY)
Baltimore oriole (BAOR)	*Icterus galbula*	2022	Pair	3	-2.1 (MA) -1.54 (NY)
Barn swallow (BARS)	*Hirundo rustica*	2021	Solar	34	-0.73 (MA) -0.9 (NY)
Barn swallow (BARS)	*Hirundo rustica*	2021	Pair	67	-0.73 (MA) -0.9 (NY)
Barn swallow (BARS)	*Hirundo rustica*	2022	Solar	60	-0.73 (MA) -0.9 (NY)
Barn swallow (BARS)	*Hirundo rustica*	2022	Pair	42	-0.73 (MA) -0.9 (NY)
Black-and-white warbler (BAWW)	*Mniotilta varia*	2021	Solar	1	-1.86 (MA) -0.65 (NY)
Black-and-white warbler (BAWW)	*Mniotilta varia*	2021	Pair	0	-1.86 (MA) -0.65 (NY)
Black-and-white warbler (BAWW)	*Mniotilta varia*	2022	Solar	1	-1.86 (MA) -0.65 (NY)
Black-and-white warbler (BAWW)	*Mniotilta varia*	2022	Pair	2	-1.86 (MA) -0.65 (NY)
Black-billed cuckoo (BBCU)	*Coccyzus erythropthalmus*	2021	Solar	0	2.24 (MA) -1.54 (NY)
Black-billed cuckoo (BBCU)	*Coccyzus erythropthalmus*	2021	Pair	0	2.24 (MA) -1.54 (NY)

Table A-1. (continued)

Species Common Name (AOU Code)	Species Scientific Name	Survey Year	Solar or Pair	Number Obs	BBS Trend
Black-billed cuckoo (BBCU)	*Coccyzus erythropthalmus*	2022	Solar	1	2.24 (MA) -1.54 (NY)
Black-billed cuckoo (BBCU)	*Coccyzus erythropthalmus*	2022	Pair	0	2.24 (MA) -1.54 (NY)
Black-capped chickadee (BCCH)	*Poecile atricapillus*	2021	Solar	3	-0.55 (MA) 0.62 (NY)
Black-capped chickadee (BCCH)	*Poecile atricapillus*	2021	Pair	11	-0.55 (MA) 0.62 (NY)
Black-capped chickadee (BCCH)	*Poecile atricapillus*	2022	Solar	4	-0.55 (MA) 0.62 (NY)
Black-capped chickadee (BCCH)	*Poecile atricapillus*	2022	Pair	7	-0.55 (MA) 0.62 (NY)
Black-throated blue warbler (BTBW)	*Setophaga caerulescens*	2021	Solar	0	-0.08 (MA) -1.09 (NY)
Black-throated blue warbler (BTBW)	*Setophaga caerulescens*	2021	Pair	0	-0.08 (MA) -1.09 (NY)
Black-throated blue warbler (BTBW)	*Setophaga caerulescens*	2022	Solar	0	-0.08 (MA) -1.09 (NY)
Black-throated blue warbler (BTBW)	*Setophaga caerulescens*	2022	Pair	1	-0.08 (MA) -1.09 (NY)
Black-throated green warbler (BTGW)	*Setophaga virens*	2021	Solar	0	-0.31 (MA) -0.92 (NY)
Black-throated green warbler (BTGW)	*Setophaga virens*	2021	Pair	0	-0.31 (MA) -0.92 (NY)
Black-throated green warbler (BTGW)	*Setophaga virens*	2022	Solar	0	-0.31 (MA) -0.92 (NY)
Black-throated green warbler (BTGW)	*Setophaga virens*	2022	Pair	1	-0.31 (MA) -0.92 (NY)
Blue jay (BLJA)	*Cyanocitta cristata*	2021	Solar	4	-2.54 (MA) 0.03 (NY)

Table A-1. (continued)

Species Common Name (AOU Code)	Species Scientific Name	Survey Year	Solar or Pair	Number Obs	BBS Trend
Blue jay (BLJA)	*Cyanocitta cristata*	2021	Pair	6	-2.54 (MA) 0.03 (NY)
Blue jay (BLJA)	*Cyanocitta cristata*	2022	Solar	1	-2.54 (MA) 0.03 (NY)
Blue jay (BLJA)	*Cyanocitta cristata*	2022	Pair	6	-2.54 (MA) 0.03 (NY)
Blue-headed vireo (BHVI)	*Vireo solitarius*	2021	Solar	0	3.63 (MA) 2.09 (NY)
Blue-headed vireo (BHVI)	*Vireo solitarius*	2021	Pair	0	3.63 (MA) 2.09 (NY)
Blue-headed vireo (BHVI)	*Vireo solitarius*	2022	Solar	1	3.63 (MA) 2.09 (NY)
Blue-headed vireo (BHVI)	*Vireo solitarius*	2022	Pair	0	3.63 (MA) 2.09 (NY)
Blue-winged warbler (BWWA)	*Vermivora cyanoptera*	2021	Solar	1	-2.04 (MA) -0.41 (NY)
Blue-winged warbler (BWWA)	*Vermivora cyanoptera*	2021	Pair	0	-2.04 (MA) -0.41 (NY)
Blue-winged warbler (BWWA)	*Vermivora cyanoptera*	2022	Solar	0	-2.04 (MA) -0.41 (NY)
Blue-winged warbler (BWWA)	*Vermivora cyanoptera*	2022	Pair	3	-2.04 (MA) -0.41 (NY)
Bobolink (BOBO)	*Dolichonyx oryzivorus*	2021	Solar	2	-0.18 (MA) -1.68 (NY)
Bobolink (BOBO)	*Dolichonyx oryzivorus*	2021	Pair	65	-0.18 (MA) -1.68 (NY)
Bobolink (BOBO)	*Dolichonyx oryzivorus*	2022	Solar	3	-0.18 (MA) -1.68 (NY)
Bobolink (BOBO)	*Dolichonyx oryzivorus*	2022	Pair	45	-0.18 (MA) -1.68 (NY)

Table A-1. (continued)

Species Common Name (AOU Code)	Species Scientific Name	Survey Year	Solar or Pair	Number Obs	BBS Trend
Brown thrasher (BRTH)	*Toxostoma rufum*	2021	Solar	0	-5.45 (MA) -2.13 (NY)
Brown thrasher (BRTH)	*Toxostoma rufum*	2021	Pair	4	-5.45 (MA) -2.13 (NY)
Brown thrasher (BRTH)	*Toxostoma rufum*	2022	Solar	2	-5.45 (MA) -2.13 (NY)
Brown thrasher (BRTH)	*Toxostoma rufum*	2022	Pair	1	-5.45 (MA) -2.13 (NY)
Brown-headed cowbird (BHCO)	*Molothrus ater*	2021	Solar	4	-0.2 (MA) -2.14 (NY)
Brown-headed cowbird (BHCO)	*Molothrus ater*	2021	Pair	4	-0.2 (MA) -2.14 (NY)
Brown-headed cowbird (BHCO)	*Molothrus ater*	2022	Solar	4	-0.2 (MA) -2.14 (NY)
Brown-headed cowbird (BHCO)	*Molothrus ater*	2022	Pair	5	-0.2 (MA) -2.14 (NY)
Carolina wren (CARW)	*Thryothorus ludovicianus*	2021	Solar	1	9.03 (MA) 7.65 (NY)
Carolina wren (CARW)	*Thryothorus ludovicianus*	2021	Pair	0	9.03 (MA) 7.65 (NY)
Carolina wren (CARW)	*Thryothorus ludovicianus*	2022	Solar	0	9.03 (MA) 7.65 (NY)
Carolina wren (CARW)	*Thryothorus ludovicianus*	2022	Pair	1	9.03 (MA) 7.65 (NY)
Cedar waxwing (CEDW)	*Bombycilla cedrorum*	2021	Solar	5	1.02 (MA) -0.34 (NY)
Cedar waxwing (CEDW)	*Bombycilla cedrorum*	2021	Pair	13	1.02 (MA) -0.34 (NY)
Cedar waxwing (CEDW)	*Bombycilla cedrorum*	2022	Solar	6	1.02 (MA) -0.34 (NY)

Table A-1. (continued)

Species Common Name (AOU Code)	Species Scientific Name	Survey Year	Solar or Pair	Number Obs	BBS Trend
Cedar waxwing (CEDW)	*Bombycilla cedrorum*	2022	Pair	9	1.02 (MA) -0.34 (NY)
Chestnut-sided warbler (CSWA)	*Setophaga pensylvanica*	2021	Solar	4	-1.18 (MA) -0.62 (NY)
Chestnut-sided warbler (CSWA)	*Setophaga pensylvanica*	2021	Pair	2	-1.18 (MA) -0.62 (NY)
Chestnut-sided warbler (CSWA)	*Setophaga pensylvanica*	2022	Solar	7	-1.18 (MA) -0.62 (NY)
Chestnut-sided warbler (CSWA)	*Setophaga pensylvanica*	2022	Pair	3	-1.18 (MA) -0.62 (NY)
Chimney swift (CHSW)	*Chaetura pelagica*	2021	Solar	4	-2.01 (MA) -1.5 (NY)
Chimney swift (CHSW)	*Chaetura pelagica*	2021	Pair	2	-2.01 (MA) -1.5 (NY)
Chimney swift (CHSW)	*Chaetura pelagica*	2022	Solar	3	-2.01 (MA) -1.5 (NY)
Chimney swift (CHSW)	*Chaetura pelagica*	2022	Pair	0	-2.01 (MA) -1.5 (NY)
Chipping sparrow (CHSP)	*Spizella passerina*	2021	Solar	7	0.38 (MA) -1.07 (NY)
Chipping sparrow (CHSP)	*Spizella passerina*	2021	Pair	2	0.38 (MA) -1.07 (NY)
Chipping sparrow (CHSP)	*Spizella passerina*	2022	Solar	14	0.38 (MA) -1.07 (NY)
Chipping sparrow (CHSP)	*Spizella passerina*	2022	Pair	0	0.38 (MA) -1.07 (NY)
Common grackle (COGR)	*Quiscalus quiscula*	2021	Solar	4	-2.76 (MA) -1.74 (NY)
Common grackle (COGR)	*Quiscalus quiscula*	2021	Pair	0	-2.76 (MA) -1.74 (NY)

Table A-1. (continued)

Species Common Name (AOU Code)	Species Scientific Name	Survey Year	Solar or Pair	Number Obs	BBS Trend
Common grackle (COGR)	*Quiscalus quiscula*	2022	Solar	6	-2.76 (MA) -1.74 (NY)
Common grackle (COGR)	*Quiscalus quiscula*	2022	Pair	1	-2.76 (MA) -1.74 (NY)
Common yellowthroat (COYE)	*Geothlypis trichas*	2021	Solar	14	-1.65 (MA) -0.25 (NY)
Common yellowthroat (COYE)	*Geothlypis trichas*	2021	Pair	54	-1.65 (MA) -0.25 (NY)
Common yellowthroat (COYE)	*Geothlypis trichas*	2022	Solar	25	-1.65 (MA) -0.25 (NY)
Common yellowthroat (COYE)	*Geothlypis trichas*	2022	Pair	53	-1.65 (MA) -0.25 (NY)
Cooper's hawk (COHA)	*Accipiter cooperii*	2021	Solar	0	3.92 (MA) 2.95 (NY)
Cooper's hawk (COHA)	*Accipiter cooperii*	2021	Pair	0	3.92 (MA) 2.95 (NY)
Cooper's hawk (COHA)	*Accipiter cooperii*	2022	Solar	1	3.92 (MA) 2.95 (NY)
Cooper's hawk (COHA)	*Accipiter cooperii*	2022	Pair	0	3.92 (MA) 2.95 (NY)
Downy woodpecker (DOWO)	*Dryobates pubescens*	2021	Solar	2	NA
Downy woodpecker (DOWO)	*Dryobates pubescens*	2021	Pair	3	NA
Downy woodpecker (DOWO)	*Dryobates pubescens*	2022	Solar	2	NA
Downy woodpecker (DOWO)	*Dryobates pubescens*	2022	Pair	8	NA
Eastern bluebird (EABL)	*Sialia sialis*	2021	Solar	5	1.61 (MA) 1.92 (NY)

Table A-1. (continued)

Species Common Name (AOU Code)	Species Scientific Name	Survey Year	Solar or Pair	Number Obs	BBS Trend
Eastern bluebird (EABL)	*Sialia sialis*	2021	Pair	2	1.61 (MA) 1.92 (NY)
Eastern bluebird (EABL)	*Sialia sialis*	2022	Solar	11	1.61 (MA) 1.92 (NY)
Eastern bluebird (EABL)	*Sialia sialis*	2022	Pair	3	1.61 (MA) 1.92 (NY)
Eastern kingbird (EAKI)	*Tyrannus tyrannus*	2021	Solar	6	-3.06 (MA) -1.44 (NY)
Eastern kingbird (EAKI)	*Tyrannus tyrannus*	2021	Pair	7	-3.06 (MA) -1.44 (NY)
Eastern kingbird (EAKI)	*Tyrannus tyrannus*	2022	Solar	5	-3.06 (MA) -1.44 (NY)
Eastern kingbird (EAKI)	*Tyrannus tyrannus*	2022	Pair	2	-3.06 (MA) -1.44 (NY)
Eastern meadowlark (EAME)	*Sturnella magna*	2021	Solar	3	-8.74 (MA) -5.75 (NY)
Eastern meadowlark (EAME)	*Sturnella magna*	2021	Pair	2	-8.74 (MA) -5.75 (NY)
Eastern meadowlark (EAME)	*Sturnella magna*	2022	Solar	1	-8.74 (MA) -5.75 (NY)
Eastern meadowlark (EAME)	*Sturnella magna*	2022	Pair	12	-8.74 (MA) -5.75 (NY)
Eastern phoebe (EAPH)	*Sayornis phoebe*	2021	Solar	10	-0.5 (MA) -0.82 (NY)
Eastern phoebe (EAPH)	*Sayornis phoebe*	2021	Pair	5	-0.5 (MA) -0.82 (NY)
Eastern phoebe (EAPH)	*Sayornis phoebe*	2022	Solar	10	-0.5 (MA) -0.82 (NY)
Eastern phoebe (EAPH)	*Sayornis phoebe*	2022	Pair	2	-0.5 (MA) -0.82 (NY)

Table A-1. (continued)

Species Common Name (AOU Code)	Species Scientific Name	Survey Year	Solar or Pair	Number Obs	BBS Trend
Eastern towhee (EATO)	*Pipilo erythrophthalmus*	2021	Solar	0	-4.23 (MA) -2.77 (NY)
Eastern towhee (EATO)	*Pipilo erythrophthalmus*	2021	Pair	8	-4.23 (MA) -2.77 (NY)
Eastern towhee (EATO)	*Pipilo erythrophthalmus*	2022	Solar	0	-4.23 (MA) -2.77 (NY)
Eastern towhee (EATO)	*Pipilo erythrophthalmus*	2022	Pair	7	-4.23 (MA) -2.77 (NY)
Eastern wood-pewee (EAWP)	*Contopus virens*	2021	Solar	5	-0.45 (MA) -0.36 (NY)
Eastern wood-pewee (EAWP)	*Contopus virens*	2021	Pair	1	-0.45 (MA) -0.36 (NY)
Eastern wood-pewee (EAWP)	*Contopus virens*	2022	Solar	0	-0.45 (MA) -0.36 (NY)
Eastern wood-pewee (EAWP)	*Contopus virens*	2022	Pair	6	-0.45 (MA) -0.36 (NY)
Empidonax/flycatcher species	—	2021	Solar	0	NA
Empidonax/flycatcher species	—	2021	Pair	1	NA
Empidonax/flycatcher species	—	2022	Solar	1	NA
Empidonax/flycatcher species	—	2022	Pair	2	NA
European starling (EUST)	*Sturnus vulgaris*	2021	Solar	4	-4.26 (MA) -2.01 (NY)
European starling (EUST)	*Sturnus vulgaris*	2021	Pair	9	-4.26 (MA) -2.01 (NY)
European starling (EUST)	*Sturnus vulgaris*	2022	Solar	24	-4.26 (MA) -2.01 (NY)
European starling (EUST)	*Sturnus vulgaris*	2022	Pair	9	-4.26 (MA) -2.01 (NY)

Table A-1. (continued)

Species Common Name (AOU Code)	Species Scientific Name	Survey Year	Solar or Pair	Number Obs	BBS Trend
Field sparrow (FISP)	*Spizella pusilla*	2021	Solar	7	-3.1 (MA) -2.82 (NY)
Field sparrow (FISP)	*Spizella pusilla*	2021	Pair	23	-3.1 (MA) -2.82 (NY)
Field sparrow (FISP)	*Spizella pusilla*	2022	Solar	14	-3.1 (MA) -2.82 (NY)
Field sparrow (FISP)	*Spizella pusilla*	2022	Pair	12	-3.1 (MA) -2.82 (NY)
Fish crow (FICR)	*Corvus ossifragus*	2021	Solar	0	12.57 (MA) 1.26 (NY)
Fish crow (FICR)	*Corvus ossifragus*	2021	Pair	0	12.57 (MA) 1.26 (NY)
Fish crow (FICR)	*Corvus ossifragus*	2022	Solar	0	12.57 (MA) 1.26 (NY)
Fish crow (FICR)	*Corvus ossifragus*	2022	Pair	1	12.57 (MA) 1.26 (NY)
Grasshopper sparrow (GRSP)	*Ammodramus savannarum*	2021	Solar	0	-3.32 (MA) -7.12 (NY)
Grasshopper sparrow (GRSP)	*Ammodramus savannarum*	2021	Pair	0	-3.32 (MA) -7.12 (NY)
Grasshopper sparrow (GRSP)	*Ammodramus savannarum*	2022	Solar	0	-3.32 (MA) -7.12 (NY)
Grasshopper sparrow (GRSP)	*Ammodramus savannarum*	2022	Pair	2	-3.32 (MA) -7.12 (NY)
Gray catbird (GRCA)	*Dumetella carolinensis*	2021	Solar	24	0.28 (MA) 0.4 (NY)
Gray catbird (GRCA)	*Dumetella carolinensis*	2021	Pair	23	0.28 (MA) 0.4 (NY)
Gray catbird (GRCA)	*Dumetella carolinensis*	2022	Solar	30	0.28 (MA) 0.4 (NY)

Table A-1. (continued)

Species Common Name (AOU Code)	Species Scientific Name	Survey Year	Solar or Pair	Number Obs	BBS Trend
Gray catbird (GRCA)	*Dumetella carolinensis*	2022	Pair	25	0.28 (MA) 0.4 (NY)
Great-crested flycatcher (GCFL)	*Myiarchus crinitus*	2021	Solar	0	-0.54 (MA) -0.49 (NY)
Great-crested flycatcher (GCFL)	*Myiarchus crinitus*	2021	Pair	0	-0.54 (MA) -0.49 (NY)
Great-crested flycatcher (GCFL)	*Myiarchus crinitus*	2022	Solar	1	-0.54 (MA) -0.49 (NY)
Great-crested flycatcher (GCFL)	*Myiarchus crinitus*	2022	Pair	2	-0.54 (MA) -0.49 (NY)
Hairy woodpecker (HAWO)	*Dryobates villosus*	2021	Solar	0	0.39 (MA) 0.74 (NY)
Hairy woodpecker (HAWO)	*Dryobates villosus*	2021	Pair	0	0.39 (MA) 0.74 (NY)
Hairy woodpecker (HAWO)	*Dryobates villosus*	2022	Solar	1	0.39 (MA) 0.74 (NY)
Hairy woodpecker (HAWO)	*Dryobates villosus*	2022	Pair	0	0.39 (MA) 0.74 (NY)
House finch (HOFI)	*Haemorhous mexicanus*	2021	Solar	59	8.65 (MA) 4.49 (NY)
House finch (HOFI)	*Haemorhous mexicanu*	2021	Pair	1	8.65 (MA) 4.49 (NY)
House finch (HOFI)	*Haemorhous mexicanu*	2022	Solar	102	8.65 (MA) 4.49 (NY)
House finch (HOFI)	*Haemorhous mexicanu*	2022	Pair	0	8.65 (MA) 4.49 (NY)
House sparrow (HOSP)	*Passer domesticus*	2021	Solar	3	-1.06 (MA) -1.79 (NY)
House sparrow (HOSP)	*Passer domesticus*	2021	Pair	0	-1.06 (MA) -1.79 (NY)

Table A-1. (continued)

Species Common Name (AOU Code)	Species Scientific Name	Survey Year	Solar or Pair	Number Obs	BBS Trend
House sparrow (HOSP)	*Passer domesticus*	2022	Solar	11	-1.06 (MA) -1.79 (NY)
House sparrow (HOSP)	*Passer domesticus*	2022	Pair	0	-1.06 (MA) -1.79 (NY)
House wren (HOWR)	*Troglodytes aedon*	2021	Solar	5	0.02 (MA) -0.1 (NY)
House wren (HOWR)	*Troglodytes aedon*	2021	Pair	7	0.02 (MA) -0.1 (NY)
House wren (HOWR)	*Troglodytes aedon*	2022	Solar	4	0.02 (MA) -0.1 (NY)
House wren (HOWR)	*Troglodytes aedon*	2022	Pair	3	0.02 (MA) -0.1 (NY)
Indigo bunting (INBU)	*Passerina cyanea*	2021	Solar	6	-0.04 (MA) -0.68 (NY)
Indigo bunting (INBU)	*Passerina cyanea*	2021	Pair	0	-0.04 (MA) -0.68 (NY)
Indigo bunting (INBU)	*Passerina cyanea*	2022	Solar	8	-0.04 (MA) -0.68 (NY)
Indigo bunting (INBU)	*Passerina cyanea*	2022	Pair	13	-0.04 (MA) -0.68 (NY)
Killdeer (KILL)	*Charadrius vociferus*	2021	Solar	1	-1.65 (MA) -1.82 (NY)
Killdeer (KILL)	*Charadrius vociferus*	2021	Pair	13	-1.65 (MA) -1.82 (NY)
Killdeer (KILL)	*Charadrius vociferus*	2022	Solar	1	-1.65 (MA) -1.82 (NY)
Killdeer (KILL)	*Charadrius vociferus*	2022	Pair	0	-1.65 (MA) -1.82 (NY)

Table A-1. (continued)

Species Common Name (AOU Code)	Species Scientific Name	Survey Year	Solar or Pair	Number Obs	BBS Trend
Least flycatcher (LEFL)	*Empidonax minimus*	2021	Solar	0	-2.26 (MA) -2.2 (NY)
Least flycatcher (LEFL)	*Empidonax minimus*	2021	Pair	1	2.26 (MA) -2.2 (NY)
Least flycatcher (LEFL)	*Empidonax minimus*	2022	Solar	0	2.26 (MA) -2.2 (NY)
Least flycatcher (LEFL)	*Empidonax minimus*	2022	Pair	0	2.26 (MA) -2.2 (NY)
Mallard (MALL)	*Anas platyrhynchos*	2021	Solar	0	0.63 (MA) 1.34 (NY)
Mallard (MALL)	*Anas platyrhynchos*	2021	Pair	0	0.63 (MA) 1.34 (NY)
Mallard (MALL)	*Anas platyrhynchos*	2022	Solar	2	0.63 (MA) 1.34 (NY)
Mallard (MALL)	*Anas platyrhynchos*	2022	Pair	0	0.63 (MA) 1.34 (NY)
Mourning dove (MODO)	*Zenaida macroura*	2021	Solar	2	1.09 (MA) 1.49 (NY)
Mourning dove (MODO)	*Zenaida macroura*	2021	Pair	3	1.09 (MA) 1.49 (NY)
Mourning dove (MODO)	*Zenaida macroura*	2022	Solar	10	1.09 (MA) 1.49 (NY)
Mourning dove (MODO)	*Zenaida macroura*	2022	Pair	2	1.09 (MA) 1.49 (NY)
Northern cardinal (NOCA)	*Cardinalis cardinalis*	2021	Solar	2	6.43 (MA) 2 (NY)
Northern cardinal (NOCA)	*Cardinalis cardinalis*	2021	Pair	7	6.43 (MA) 2 (NY)
Northern cardinal (NOCA)	*Cardinalis cardinalis*	2022	Solar	6	6.43 (MA) 2 (NY)

Table A-1. (continued)

Species Common Name (AOU Code)	Species Scientific Name	Survey Year	Solar or Pair	Number Obs	BBS Trend
Northern cardinal (NOCA)	*Cardinalis cardinalis*	2022	Pair	9	6.43 (MA) 2 (NY)
Northern flicker (NOFL)	*Colaptes auratus*	2021	Solar	0	-2.59 (MA) -2.28 (NY)
Northern flicker (NOFL)	*Colaptes auratus*	2021	Pair	2	-2.59 (MA) -2.28 (NY)
Northern flicker (NOFL)	*Colaptes auratus*	2022	Solar	3	-2.59 (MA) -2.28 (NY)
Northern flicker (NOFL)	*Colaptes auratus*	2022	Pair	7	-2.59 (MA) -2.28 (NY)
Northern mockingbird (NOMO)	*Mimus polyglottos*	2021	Solar	0	1.88 (MA) 2.32 (NY)
Northern mockingbird (NOMO)	*Mimus polyglottos*	2021	Pair	0	1.88 (MA) 2.32 (NY)
Northern mockingbird (NOMO)	*Mimus polyglottos*	2022	Solar	0	1.88 (MA) 2.32 (NY)
Northern mockingbird (NOMO)	*Mimus polyglottos*	2022	Pair	1	1.88 (MA) 2.32 (NY)
Northern rough-winged swallow (NRWS)	*Stelgidopteryx serripennis*	2021	Solar	3	0.37 (MA) -0.78 (NY)
Northern rough-winged swallow (NRWS)	*Stelgidopteryx serripennis*	2021	Pair	0	0.37 (MA) -0.78 (NY)
Northern rough-winged swallow (NRWS)	*Stelgidopteryx serripennis*	2022	Solar	0	0.37 (MA) -0.78 (NY)
Northern rough-winged swallow (NRWS)	*Stelgidopteryx serripennis*	2022	Pair	0	0.37 (MA) -0.78 (NY)
Orchard oriole (OROR)	*Icterus spurius*	2021	Solar	0	3.72 (MA) 2.48 (NY)
Orchard oriole (OROR)	*Icterus spurius*	2021	Pair	0	3.72 (MA) 2.48 (NY)

Table A-1. (continued)

Species Common Name (AOU Code)	Species Scientific Name	Survey Year	Solar or Pair	Number Obs	BBS Trend
Orchard oriole (OROR)	*Icterus spurius*	2022	Solar	1	3.72 (MA) 2.48 (NY)
Orchard oriole (OROR)	*Icterus spurius*	2022	Pair	0	3.72 (MA) 2.48 (NY)
Ovenbird (OVEN)	*Seiurus aurocapilla*	2021	Solar	0	0.13 (MA) 1.27 (NY)
Ovenbird (OVEN)	*Seiurus aurocapilla*	2021	Pair	3	0.13 (MA) 1.27 (NY)
Ovenbird (OVEN)	*Seiurus aurocapilla*	2022	Solar	4	0.13 (MA) 1.27 (NY)
Ovenbird (OVEN)	*Seiurus aurocapilla*	2022	Pair	1	0.13 (MA) 1.27 (NY)
Pileated woodpecker (PIWO)	*Dryocopus pileatus*	2021	Solar	0	4.63 (MA) 2.64 (NY)
Pileated woodpecker (PIWO)	*Dryocopus pileatus*	2021	Pair	0	4.63 (MA) 2.64 (NY)
Pileated woodpecker (PIWO)	*Dryocopus pileatus*	2022	Solar	0	4.63 (MA) 2.64 (NY)
Pileated woodpecker (PIWO)	*Dryocopus pileatus*	2022	Pair	4	4.63 (MA) 2.64 (NY)
Prairie warbler (PRAW)	*Setophaga discolor*	2021	Solar	0	-2.36 (MA) 1.44 (NY)
Prairie warbler (PRAW)	*Setophaga discolor*	2021	Pair	5	-2.36 (MA) 1.44 (NY)
Prairie warbler (PRAW)	*Setophaga discolor*	2022	Solar	0	-2.36 (MA) 1.44 (NY)
Prairie warbler (PRAW)	*Setophaga discolor*	2022	Pair	9	-2.36 (MA) 1.44 (NY)
Red-bellied woodpecker (RBWO)	*Melanerpes carolinus*	2021	Solar	1	13.71 (MA) 7.28 (NY)

Table A-1. (continued)

Species Common Name (AOU Code)	Species Scientific Name	Survey Year	Solar or Pair	Number Obs	BBS Trend
Red-bellied woodpecker (RBWO)	*Melanerpes carolinus*	2021	Pair	1	13.71 (MA) 7.28 (NY)
Red-bellied woodpecker (RBWO)	*Melanerpes carolinus*	2022	Solar	5	13.71 (MA) 7.28 (NY)
Red-bellied woodpecker (RBWO)	*Melanerpes carolinus*	2022	Pair	1	13.71 (MA) 7.28 (NY)
Red-breasted nuthatch (RBNU)	*Sitta canadensis*	2021	Solar	0	1.2 (MA) 2.31 (NY)
Red-breasted nuthatch (RBNU)	*Sitta canadensis*	2021	Pair	1	1.2 (MA) 2.31 (NY)
Red-breasted nuthatch (RBNU)	*Sitta canadensis*	2022	Solar	0	1.2 (MA) 2.31 (NY)
Red-breasted nuthatch (RBNU)	*Sitta canadensis*	2022	Pair	0	1.2 (MA) 2.31 (NY)
Red-eyed vireo (REVI)	*Vireo olivaceus*	2021	Solar	1	-0.02 (MA) 0.98 (NY)
Red-eyed vireo (REVI)	*Vireo olivaceus*	2021	Pair	10	-0.02 (MA) 0.98 (NY)
Red-eyed vireo (REVI)	*Vireo olivaceus*	2022	Solar	5	-0.02 (MA) 0.98 (NY)
Red-eyed vireo (REVI)	*Vireo olivaceus*	2022	Pair	8	-0.02 (MA) 0.98 (NY)
Red-shouldered hawk (RSHA)	*Buteo lineatus*	2021	Solar	0	3.49 (MA) 0.95 (NY)
Red-shouldered hawk (RSHA)	*Buteo lineatus*	2021	Pair	1	3.49 (MA) 0.95 (NY)
Red-shouldered hawk (RSHA)	*Buteo lineatus*	2022	Solar	0	3.49 (MA) 0.95 (NY)
Red-shouldered hawk (RSHA)	*Buteo lineatus*	2022	Pair	3	3.49 (MA) 0.95 (NY)

Table A-1. (continued)

Species Common Name (AOU Code)	Species Scientific Name	Survey Year	Solar or Pair	Number Obs	BBS Trend
Red-tailed hawk (RTHA)	*Buteo jamaicensis*	2021	Solar	0	3.07 (MA) 0.97 (NY)
Red-tailed hawk (RTHA)	*Buteo jamaicensis*	2021	Pair	1	3.07 (MA) 0.97 (NY)
Red-tailed hawk (RTHA)	*Buteo jamaicensis*	2022	Solar	0	3.07 (MA) 0.97 (NY)
Red-tailed hawk (RTHA)	*Buteo jamaicensis*	2022	Pair	0	3.07 (MA) 0.97 (NY)
Red-winged blackbird (RWBL)	*Agelaius phoeniceus*	2021	Solar	74	-0.82 (MA) -1.76 (NY)
Red-winged blackbird (RWBL)	*Agelaius phoeniceus*	2021	Pair	60	-0.82 (MA) -1.76 (NY)
Red-winged blackbird (RWBL)	*Agelaius phoeniceus*	2022	Solar	95	-0.82 (MA) -1.76 (NY)
Red-winged blackbird (RWBL)	*Agelaius phoeniceus*	2022	Pair	91	-0.82 (MA) -1.76 (NY)
Rose-breasted grosbeak (RBGR)	*Pheucticus ludovicianus*	2021	Solar	0	-1.36 (MA) -1.24 (NY)
Rose-breasted grosbeak (RBGR)	*Pheucticus ludovicianus*	2021	Pair	0	-1.36 (MA) -1.24 (NY)
Rose-breasted grosbeak (RBGR)	*Pheucticus ludovicianus*	2022	Solar	0	-1.36 (MA) -1.24 (NY)
Rose-breasted grosbeak (RBGR)	*Pheucticus ludovicianus*	2022	Pair	1	-1.36 (MA) -1.24 (NY)
Savannah sparrow (SAVS)	*Passerculus sandwichensis*	2021	Solar	6	-1.06 (MA) -3.15 (NY)
Savannah sparrow (SAVS)	*Passerculus sandwichensis*	2021	Pair	20	-1.06 (MA) -3.15 (NY)
Savannah sparrow (SAVS)	*Passerculus sandwichensis*	2022	Solar	5	-1.06 (MA) -3.15 (NY)

Table A-1. (continued)

Species Common Name (AOU Code)	Species Scientific Name	Survey Year	Solar or Pair	Number Obs	BBS Trend
Savannah sparrow (SAVS)	*Passerculus sandwichensis*	2022	Pair	46	-1.06 (MA) -3.15 (NY)
Scarlet tanager (SCTA)	*Piranga olivacea*	2021	Solar	1	-1.03 (MA) -0.93 (NY)
Scarlet tanager (SCTA)	*Piranga olivacea*	2021	Pair	1	-1.03 (MA) -0.93 (NY)
Scarlet tanager (SCTA)	*Piranga olivacea*	2022	Solar	0	-1.03 (MA) -0.93 (NY)
Scarlet tanager (SCTA)	*Piranga olivacea*	2022	Pair	6	-1.03 (MA) -0.93 (NY)
Song sparrow (SOSP)	*Melospiza melodia*	2021	Solar	200	-1.04 (MA) -0.95 (NY)
Song sparrow (SOSP)	*Melospiza melodia*	2021	Pair	83	-1.04 (MA) -0.95 (NY)
Song sparrow (SOSP)	*Melospiza melodia*	2022	Solar	305	-1.04 (MA) -0.95 (NY)
Song sparrow (SOSP)	*Melospiza melodia*	2022	Pair	111	-1.04 (MA) -0.95 (NY)
Swamp sparrow (SWSP)	*Melospiza georgiana*	2021	Solar	1	0.56 (MA) 0.17 (NY)
Swamp sparrow (SWSP)	*Melospiza georgiana*	2021	Pair	1	0.56 (MA) 0.17 (NY)
Swamp sparrow (SWSP)	*Melospiza georgiana*	2022	Solar	0	0.56 (MA) 0.17 (NY)
Swamp sparrow (SWSP)	*Melospiza georgiana*	2022	Pair	3	0.56 (MA) 0.17 (NY)
Tree swallow (TRES)	*Tachycineta bicolor*	2021	Solar	5	-0.7 (MA) -0.49 (NY)
Tree swallow (TRES)	*Tachycineta bicolor*	2021	Pair	10	-0.7 (MA) -0.49 (NY)

Table A-1. (continued)

Species Common Name (AOU Code)	Species Scientific Name	Survey Year	Solar or Pair	Number Obs	BBS Trend
Tree swallow (TRES)	*Tachycineta bicolor*	2022	Solar	6	-0.7 (MA) -0.49 (NY)
Tree swallow (TRES)	*Tachycineta bicolor*	2022	Pair	37	-0.7 (MA) -0.49 (NY)
Tufted titmouse (TUTI)	*Baeolophus bicolor*	2021	Solar	1	8.24 (MA) 4.72 (NY)
Tufted titmouse (TUTI)	*Baeolophus bicolor*	2021	Pair	6	8.24 (MA) 4.72 (NY)
Tufted titmouse (TUTI)	*Baeolophus bicolor*	2022	Solar	2	8.24 (MA) 4.72 (NY)
Tufted titmouse (TUTI)	*Baeolophus bicolor*	2022	Pair	4	8.24 (MA) 4.72 (NY)
Unknown/ unconfirmed	—	2021	Solar	1	NA
Unknown/ unconfirmed	—	2021	Pair	1	NA
Unknown/ unconfirmed	—	2022	Solar	2	NA
Unknown/ unconfirmed	—	2022	Pair	1	NA
Veery (VEER)	*Catharus fuscescens*	2021	Solar	0	-0.74 (MA) -1.68 (NY)
Veery (VEER)	*Catharus fuscescens*	2021	Pair	2	-0.74 (MA) -1.68 (NY)
Veery (VEER)	*Catharus fuscescens*	2022	Solar	0	-0.74 (MA) -1.68 (NY)
Veery (VEER)	*Catharus fuscescens*	2022	Pair	0	-0.74 (MA) -1.68 (NY)
Warbling vireo (WAVI)	*Vireo gilvus*	2021	Solar	1	3.13 (MA) 1.47 (NY)
Warbling vireo (WAVI)	*Vireo gilvus*	2021	Pair	0	3.13 (MA) 1.47 (NY)
Warbling vireo (WAVI)	*Vireo gilvus*	2022	Solar	3	3.13 (MA) 1.47 (NY)

Table A-1. (continued)

Species Common Name (AOU Code)	Species Scientific Name	Survey Year	Solar or Pair	Number Obs	BBS Trend
Warbling vireo (WAVI)	*Vireo gilvus*	2022	Pair	2	3.13 (MA) 1.47 (NY)
White-breasted nuthatch (WBNU)	*Sitta carolinensis*	2021	Solar	3	1.97 (MA) 0.56 (NY)
White-breasted nuthatch (WBNU)	*Sitta carolinensis*	2021	Pair	2	1.97 (MA) 0.56 (NY)
White-breasted nuthatch (WBNU)	*Sitta carolinensis*	2022	Solar	4	1.97 (MA) 0.56 (NY)
White-breasted nuthatch (WBNU)	*Sitta carolinensis*	2022	Pair	4	1.97 (MA) 0.56 (NY)
Wild turkey (WITU)	*Meleagris gallopavo*	2021	Solar	0	11.92 (MA) 9.67 (NY)
Wild turkey (WITU)	*Meleagris gallopavo*	2021	Pair	2	11.92 (MA) 9.67 (NY)
Wild turkey (WITU)	*Meleagris gallopavo*	2022	Solar	1	11.92 (MA) 9.67 (NY)
Wild turkey (WITU)	*Meleagris gallopavo*	2022	Pair	0	11.92 (MA) 9.67 (NY)
Willow flycatcher (WIFL)	*Empidonax traillii*	2021	Solar	5	2.72 (MA) 0.42 (NY)
Willow flycatcher (WIFL)	*Empidonax traillii*	2021	Pair	2	2.72 (MA) 0.42 (NY)
Willow flycatcher (WIFL)	*Empidonax traillii*	2022	Solar	11	2.72 (MA) 0.42 (NY)
Willow flycatcher (WIFL)	*Empidonax traillii*	2022	Pair	1	2.72 (MA) 0.42 (NY)
Wood thrush (WOTH)	*Hylocichla mustelina*	2021	Solar	1	-2.87 (MA) -1.98 (NY)
Wood thrush (WOTH)	*Hylocichla mustelina*	2021	Pair	2	-2.87 (MA) -1.98 (NY)

Table A-1. (continued)

Species Common Name (AOU Code)	Species Scientific Name	Survey Year	Solar or Pair	Number Obs	BBS Trend
Wood thrush (WOTH)	*Hylocichla mustelina*	2022	Solar	0	-2.87 (MA) -1.98 (NY)
Wood thrush (WOTH)	*Hylocichla mustelina*	2022	Pair	2	-2.87 (MA) -1.98 (NY)
Yellow warbler (YEWA)	*Setophaga petechia*	2021	Solar	11	0.51 (MA) -0.73 (NY)
Yellow warbler (YEWA)	*Setophaga petechia*	2021	Pair	15	0.51 (MA) -0.73 (NY)
Yellow warbler (YEWA)	*Setophaga petechia*	2022	Solar	14	0.51 (MA) -0.73 (NY)
Yellow warbler (YEWA)	*Setophaga petechia*	2022	Pair	17	0.51 (MA) -0.73 (NY)
Yellow-bellied sapsucker (YBSA)	*Sphyrapicus varius*	2021	Solar	0	3.4 (MA) -0.31 (NY)
Yellow-bellied sapsucker (YBSA)	*Sphyrapicus varius*	2021	Pair	1	3.4 (MA) -0.31 (NY)
Yellow-bellied sapsucker (YBSA)	*Sphyrapicus varius*	2022	Solar	0	3.4 (MA) -0.31 (NY)
Yellow-bellied sapsucker (YBSA)	*Sphyrapicus varius*	2022	Pair	0	3.4 (MA) -0.31 (NY)
Yellow-throated vireo (YTVI)	*Vireo flavifrons*	2021	Solar	0	3.49 (MA) 0.37 (NY)
Yellow-throated vireo (YTVI)	*Vireo flavifrons*	2021	Pair	0	3.49 (MA) 0.37 (NY)
Yellow-throated vireo (YTVI)	*Vireo flavifrons*	2022	Solar	1	3.49 (MA) 0.37 (NY)
Yellow-throated vireo (YTVI)	*Vireo flavifrons*	2022	Pair	0	3.49 (MA) 0.37 (NY)

Table A-2. Species Occurrence across Point Count Plots

For each species, the table reports the total number and percentage of point count plots in which it was detected, by year and across both solar and paired reference sites. Species shown in bold in the Percent Plots column met the ≥ 10% of plots) and were used in occupancy and occurrence analyses. See Table A-1 for scientific names.

Species	Survey Year	Number Plots	Percent Plots
Song sparrow	2021	62	70.45
Song sparrow	2022	97	76.98
American robin	2021	35	39.77
American robin	2022	51	40.48
Red-winged blackbird	2021	28	31.82
Red-winged blackbird	2022	46	36.51
Barn swallow	2021	35	39.77
Barn swallow	2022	32	25.40
Common yellowthroat	2021	24	27.27
Common yellowthroat	2022	28	22.22
American goldfinch	2021	21	23.86
American goldfinch	2022	24	19.05
Gray catbird	2021	13	14.77
Gray catbird	2022	18	14.29
House finch	2021	11	12.5
House finch	2022	26	20.63
Yellow warbler	2021	10	11.36
Yellow warbler	2022	14	11.11
Bobolink	2021	6	6.82
Bobolink	2022	18	14.29
Field sparrow	2021	11	12.5
Field sparrow	2022	15	11.90
Eastern phoebe	2021	10	11.36
Eastern phoebe	2022	7	5.56
Savannah sparrow	2021	12	13.64
Savannah sparrow	2022	17	13.49
Tree swallow	2021	12	13.64
Tree swallow	2022	10	7.94
House wren	2021	9	10.23
House wren	2022	4	3.17
Eastern kingbird	2021	7	7.95
Eastern kingbird	2022	4	3.17
European starling	2021	7	7.95
European starling	2022	12	9.52
Indigo bunting	2021	2	2.27

Table A-2. (continued)

Species	Survey Year	Number Plots	Percent Plots
Indigo bunting	**2022**	**6**	**4.76**
Northern cardinal	2021	5	5.68
Northern cardinal	2022	8	6.35
Blue jay	2021	5	5.68
Blue jay	2022	6	4.76
Eastern bluebird	2021	2	2.27
Eastern bluebird	2022	11	8.73
Black-capped chickadee	2021	6	6.82
Black-capped chickadee	2022	5	3.97
Cedar waxwing	2021	5	5.68
Cedar waxwing	2022	6	4.76
Chipping sparrow	2021	6	6.82
Chipping sparrow	2022	6	4.76
Downy woodpecker	2021	3	3.41
Downy woodpecker	2022	7	5.56
Willow flycatcher	2021	3	3.41
Willow flycatcher	2022	3	2.38
Chestnut-sided warbler	2021	4	4.55
Chestnut-sided warbler	2022	4	3.17
Eastern meadowlark	2021	5	5.68
Eastern meadowlark	2022	7	5.56
Northern flicker	2021	1	1.14
Northern flicker	2022	6	4.76
Brown-headed cowbird	2021	3	3.41
Brown-headed cowbird	2022	3	2.38
Eastern wood-pewee	2021	6	6.82
Eastern wood-pewee	2022	3	2.38
Red-eyed vireo	2021	4	4.55
Red-eyed vireo	2022	3	2.38
White-breasted nuthatch	2021	2	2.27
White-breasted nuthatch	2022	4	3.17
Mourning dove	2021	3	3.41
Mourning dove	2022	5	3.97
House sparrow	2021	1	1.14
House sparrow	2022	4	3.17
Common grackle	2021	4	4.55
Common grackle	2022	3	2.38
Eastern towhee	2021	4	4.55

Table A-2. (continued)

Species	Survey Year	Number Plots	Percent Plots
Eastern towhee	**2022**	**4**	**3.17**
Unknown/unconfirmed	2021	3	3.41
Unknown/unconfirmed	2022	5	3.97
Tufted titmouse	2021	2	2.27
Tufted titmouse	2022	4	3.17
Warbling vireo	2021	1	1.14
Warbling vireo	2022	2	1.59
Baltimore oriole	2021	2	2.27
Baltimore oriole	2022	3	2.38
Brown thrasher	2021	3	3.41
Brown thrasher	2022	1	0.79
Ovenbird	2021	3	3.41
Ovenbird	2022	1	0.79
Prairie warbler	2021	3	3.41
Prairie warbler	2022	4	3.17
Wood thrush	2021	2	2.27
Wood thrush	2022	2	1.59
Pileated woodpecker	2021	0	0
Pileated woodpecker	2022	4	3.17
Red-bellied woodpecker	2021	1	1.14
Red-bellied woodpecker	2022	1	0.79
Scarlet tanager	2021	1	1.14
Scarlet tanager	2022	4	3.17
Black-and-white warbler	2021	0	0
Black-and-white warbler	2022	2	1.59
Empidonax/flycatcher species	2021	1	1.14
Empidonax/flycatcher species	2022	3	2.38
Great-crested flycatcher	2021	0	0
Great-crested flycatcher	2022	3	2.38
Northern rough-winged swallow	2021	3	3.41
Northern rough-winged swallow	2022	0	0
Red-shouldered hawk	2021	1	1.14
Red-shouldered hawk	2022	3	2.38
Alder flycatcher	2021	2	2.27
Alder flycatcher	2022	1	0.79
American kestrel	2021	2	2.27
American kestrel	2022	0	0
Killdeer	2021	1	1.14

Table A-2. (continued)

Species	Survey Year	Number Plots	Percent Plots
Killdeer	**2022**	**1**	**0.79**
Mallard	2021	0	0
Mallard	2022	2	1.59
Swamp sparrow	2021	2	2.27
Swamp sparrow	2022	2	1.59
Blue-winged warbler	2021	0	0
Blue-winged warbler	2022	2	1.59
American redstart	2021	1	1.14
American redstart	2022	1	0.79
Carolina wren	2021	0	0
Carolina wren	2022	1	0.79
Least flycatcher	2021	1	1.14
Least flycatcher	2022	0	0
Red-breasted nuthatch	2021	1	1.14
Red-breasted nuthatch	2022	0	0
Red-tailed hawk	2021	1	1.14
Red-tailed hawk	2022	0	0
Veery	2021	1	1.14
Veery	2022	0	0
Wild turkey	2021	1	1.14
Wild turkey	2022	1	0.79
Yellow-bellied sapsucker	2021	1	1.14
Yellow-bellied sapsucker	2022	0	0
American crow	2021	0	0
American crow	2022	1	0.79
Black-billed cuckoo	2021	0	0
Black-billed cuckoo	2022	1	0.79
Black-throated blue warbler	2021	0	0
Black-throated blue warbler	2022	1	0.79
Black-throated green warbler	2021	0	0
Black-throated green warbler	2022	1	0.79
Blue-headed vireo	2021	0	0
Blue-headed vireo	2022	1	0.79
Chimney swift	2021	0	0
Chimney swift	2022	1	0.79
Cooper’s hawk	2021	0	0
Cooper’s hawk	2022	1	0.79
Fish crow	2021	0	0

Table A-2. (continued)

Species	Survey Year	Number Plots	Percent Plots
Fish crow	**2022**	**1**	**0.79**
Grasshopper sparrow	2021	0	0
Grasshopper sparrow	2022	1	0.79
Hairy woodpecker	2021	0	0
Hairy woodpecker	2022	1	0.79
Northern mockingbird	2021	0	0
Northern mockingbird	2022	1	0.79
Orchard oriole	2021	0	0
Orchard oriole	2022	1	0.79
Rose-breasted grosbeak	2021	0	0
Rose-breasted grosbeak	2022	1	0.79
Yellow-throated vireo	2021	0	0
Yellow-throated vireo	2022	1	0.79

Table A-3. Habitat and Foraging Guild Classifications for Detected Species

Habitat guild and foraging guild assignments are provided for the 79 bird species detected during 2021 and 2022 surveys. Classifications were sourced from species accounts in *Birds of the World* (Billerman et al. 2025), Cornell Lab of Ornithology’s *All about Birds*, and other authoritative ornithological references (e.g., eBird). The table also indicates whether each species is native to New York and Massachusetts or is non-native, introduced, or invasive. Species in this table are identified by their American Ornithologists’ Union (AOU) 4-letter code and the full species names with the corresponding AOU codes are included in Table A-1.

Species	Habitat Guild	Foraging Guild	Nativity Classification
ALFL	Scrub	Insectivore	Native
AMCR	Open Woodland	Omnivore	Native
AMGO	Open Woodland	Granivore	Native
AMKE	Grassland	Carnivore	Native
AMRE	Forest	Insectivore	Native
AMRO	Open Woodland	Omnivore	Native
BAOR	Open Woodland	Omnivore	Native
BARS	Grassland	Insectivore	Native
BAWW	Forest	Insectivore	Native
BBCU	Forest	Insectivore	Native
BCCH	Forest	Omnivore	Native
BTBW	Forest	Insectivore	Native
BTGW	Forest	Insectivore	Native
BLJA	Forest	Omnivore	Native
BHVI	Forest	Insectivore	Native
BWWA	Open Woodland	Insectivore	Native
BOBO	Grassland	Granivore	Native

Table A-3. (continued)

Species	Habitat Guild	Foraging Guild	Native or Non-Native
BRTH	Scrub	Omnivore	Native
BHCO	Grassland	Granivore	Native
CARW	Open Woodland	Insectivore	Native
CEDW	Open Woodland	Frugivore	Native
CSWA	Open Woodland	Insectivore	Native
CHSW	Urban	Insectivore	Native
CHSP	Open Woodland	Granivore	Native
COGR	Open Woodland	Omnivore	Native
COYE	Scrub	Insectivore	Native
COHA	Forest	Carnivore	Native
DOWO	Forest	Insectivore	Native
EABL	Grassland	Insectivore	Native
EAKI	Grassland	Insectivore	Native
EAME	Grassland	Insectivore	Native
EAPH	Open Woodland	Insectivore	Native
EATO	Scrub	Omnivore	Native
EAWP	Forest	Insectivore	Native
EUST	Urban	Omnivore	Non-native
FISP	Scrub	Insectivore	Native
FICR	Shoreline	Omnivore	Native
GRSP	Grassland	Insectivore	Native
GRCA	Open Woodland	Omnivore	Native
GCFL	Open Woodland	Insectivore	Native
HAWO	Forest	Insectivore	Native
HOFI	Urban	Granivore	Non-native
HOSP	Urban	Omnivore	Non-native
HOWR	Scrub	Insectivore	Native
INBU	Open Woodland	Insectivore	Native
KILL	Grassland	Insectivore	Native
LEFL	Forest	Insectivore	Native
MALL	Water	Omnivore	Native
MODO	Open Woodland	Granivore	Native
NOCA	Open Woodland	Omnivore	Native
NOFL	Open Woodland	Insectivore	Native
NOMO	Urban	Omnivore	Native
NRWS	Water	Insectivore	Native
OROR	Open Woodland	Omnivore	Native
OVEN	Forest	Insectivore	Native

Table A-3. (continued)

Species	Habitat Guild	Foraging Guild	Native or Non-Native
PIWO	Forest	Insectivore	Native
PRAW	Scrub	Insectivore	Native
RBWO	Forest	Omnivore	Native
RBNU	Forest	Insectivore	Native
REVI	Forest	Insectivore	Native
RSHA	Forest	Carnivore	Native
RTHA	Grassland	Carnivore	Native
RWBL	Marsh	Omnivore	Native
RBGR	Forest	Omnivore	Native
SAVS	Grassland	Insectivore	Native
SCTA	Forest	Insectivore	Native
SOSP	Open Woodland	Omnivore	Native
SWSP	Marsh	Omnivore	Native
TRES	Water	Insectivore	Native
TUTI	Forest	Omnivore	Native
VEER	Forest	Insectivore	Native
WAVI	Open Woodland	Insectivore	Native
WBNU	Forest	Insectivore	Native
WITU	Open Woodland	Omnivore	Native
WIFL	Marsh	Insectivore	Native
WOTH	Forest	Insectivore	Native
YEWA	Open Woodland	Insectivore	Native
YBSA	Forest	Insectivore	Native
YTVI	Open Woodland	Insectivore	Native

Table A-4. Interaction between Solar Site and Habitat Guild in Negative Binomial Generalized Linear Mixed Model

Results from a negative binomial GLMM with a log link testing the interaction between PV solar sites and bird species habitat guilds. Coefficient estimates are based on abundance per 50-m fixed-radius point count and are presented on the log scale. Statistically significant *p*-values are shown in boldface.

Effect	Coefficient Estimate (log)	SE	z	*p*-value
Intercept (Forest, Reference)	-3.322	0.140	-23.82	**<0.001**
Solar (vs. Reference)	-0.681	0.190	-3.59	**<0.001**
Grassland	1.836	0.161	11.40	**0.001**
Marsh	2.265	0.229	9.90	**<0.001**
Open woodland	1.318	0.142	9.26	**<0.001**
Scrub	1.492	0.186	8.03	**<0.001**
Urban	-0.120	0.276	-0.44	0.663
Water	1.334	0.259	5.14	**<0.001**
Year 2022	-0.029	0.075	-0.39	0.698
Solar × Grassland	-0.055	0.254	-0.22	0.830
Solar × Marsh	1.044	0.335	3.11	**0.002**
Solar × Open woodland	1.300	0.220	5.91	**<0.001**
Solar × Scrub	-0.155	0.298	-0.52	0.603
Solar × Urban	2.631	0.348	7.56	**<0.001**
Solar × Water	-0.293	0.428	-0.68	0.494

Table A-5. Interaction between Solar Site and Foraging Guild in Negative Binomial Generalized Linear Mixed Model

Results from a negative binomial GLMM with a log link testing the interaction between PV solar sites and bird species foraging guilds. Coefficient estimates are based on abundance per 50-m fixed-radius point count and are presented on a log scale. Statistically significant *p*-values are shown in boldface.

Effect	Coefficient Estimate (log)	SE	z	*p*-value
Intercept (Carnivore, Reference)	-1.048	0.596	-1.76	0.079
Solar (vs. Reference)	0.253	0.763	0.33	0.740
Frugivore	0.869	0.703	1.24	0.217
Granivore	2.686	0.610	4.41	**<0.001**
Insectivore	4.047	0.591	6.85	**<0.001**
Omnivore	3.944	0.591	6.67	**<0.001**
Year 2022	-0.093	0.100	-0.93	0.353
Solar × Frugivore	-0.511	0.970	-0.53	0.598
Solar × Granivore	0.306	0.801	0.38	0.702
Solar × Insectivore	-0.607	0.780	-0.78	0.437
Solar × Omnivore	0.220	0.776	0.28	0.777

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