Avian-Solar Interactions at Photovoltaic Solar Energy Facilities in Multiple U.S. Regions

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Overview

Our stakeholder engagements in recent years and preliminary data gathered through other studies suggest a potential of misconceptions about the overall or net impacts of photovoltaic (PV) solar energy facilities on bird populations. By partnering with the solar industry, environmental consulting firms, and other experts, scientists at Argonne National Laboratory will gain insights into **the impacts and benefits of PV solar facilities on avian biodiversity**. Primary objectives are to (a) understand avian-solar collision mortality risks at facilities outside the southwest and (b) evaluate whether PV facilities may benefit avian biodiversity. We will guide this study with the following **research questions**:

1. *How do avian mortality rates at PV sites vary across U.S. regions? Are the species or guilds of bird carcasses found in other regions similar to those observed in the Pacific Southwest?*

2. *What are the primary causes of avian fatalities at PV sites? Do these mechanisms vary by region?*

3. *How do birds behave inside PV sites? How does bird behavior vary by season, time of day, and region? Are there attributes of bird behavior at PV sites correlated with increased mortality?*

4. *Are patterns of bird abundance and diversity influenced by solar facility infrastructure and vegetation management?*

A lack of data on bird interactions with PV facility infrastructure across regions of the U.S. is a central data gap. We will utilize sensing technologies (cameras and acoustic sensors) and traditional field methods (bird fatality and diversity surveys) to collect data at PV facilities located across multiple U.S. regions to fill this data gap. We will analyze these multiple data streams in an integrated manner using machine-learning models, ethograms, and statistical analyses to quantify bird diversity, bird behavior, and rates of fatality attributable to collisions for each facility and/or region. We will then compare the results by season, time of day, and regions to understand how bird behavior, diversity, and interactions with PV infrastructure varies across seasons and regions. We will engage with various stakeholders within the solar industry and other groups throughout this study to develop and implement the research plan, share progress, and address questions and concerns. Through this stakeholder engagement process, the team and stakeholders will turn the large volume of unprecedented data collected from multiple U.S. regions into a unified knowledge of avian-solar interactions for PV energy facilities.[1] We will share this knowledge with a wider scientific audience through peer-reviewed publications and professional conference presentations to facilitate sustainable PV solar energy deployment across the U.S.

[1] The Argonne team will address any data sharing concerns upon establishing a partnership.

Data Collection Methods and Field Activities

Avian data will be collected using **a combination of sensing technologies and field observations** summarized in Table 1. Data collection will be **targeted for birds' migration season**, and it is expected to begin in March or April 2024 and end in May or July 2026. Specific timing of data collection will depend on the characteristics of PV sites.

Table 1 Summary of data collection methods.

Type	Method	Period	Frequency	Site
Sensing	Video camera	Spring/fall migratory seasons	Automatic, daytime continuous	PV only
Sensing	Wildlife camera	Spring/fall migratory seasons	Automatic, motion-activated	PV only
Sensing	Acoustic recorder	Spring/fall migratory seasons	Automatic, all-time continuous	PV, reference
Field survey	Fatality/carcass survey	10-12 weeks each season	Weekly	PV only
Field survey	Carcass persistence; searcher efficiency trials	During the period of other field surveys	n/a	PV outside southwest

At each site visit, the following field activities will be conducted by the field team, consisting of Argonne personnel, biologists from environmental consulting firms, and/or qualified, trained graduate students. Fatality surveys and camera monitoring will only occur on the PV site. We will conduct acoustic monitoring on the PV sites (required) and in offsite reference areas (optional).

Video Camera Monitoring

(Required, automatic, daytime continuous during migration seasons, PV site only)

The purpose of video camera monitoring is to collect observations of avian behavior and confirm cause of mortality if a detection is made in the camera's field of view. At the beginning of each video collection period, the field team will install camera systems to continuously record daytime video for a specific portion of the survey area on the PV site and save the video recordings in external hard drives connected to the camera. Required maintenance of the system during data collection, including hard drive replacement, confirmation of power connection, and confirmation of tripod stability, will be performed by the field team.

Fatality/Carcass Surveys

(Required, once a week over 10–12 weeks, PV site only)

Distance sampling is often used at PV sites to search for carcasses and feather spots (hereafter "detections") of birds in the PV facility area (Kosciuch et al. 2021). Distance sampling is suited to PV sites, especially when vegetation is short or nonexistent and other visual barriers are absent, as it allows for efficient sampling of large areas. A searcher walks perpendicular to panel rows and looks down each row for potential detections. However, this approach will not work well at PV sites with taller, denser vegetation. In these cases, searchers will be required to walk down each panel row to look for potential detections.

Wildlife Camera Trap

(Required, automatic, motion-activated during migration seasons, PV site only)

The purpose of installing motion-activated wildlife camera traps is to collect wildlife photos at the PV site. Wildlife cameras installed across the PV site will capture the presence of wildlife during both daytime and nighttime. This information could help understand mechanisms of avian mortality inside the PV facility footprint.

Passive Acoustic Monitoring

(Required, automatic, all-time continuous during migration seasons, PV site. [Optional: offsite reference areas])

The objective of acoustic monitoring is to collect data to evaluate patterns of bird use at the PV study sites. Acoustic recorders (such as Song Meter Mini) will be used to continuously monitor avian activity, through recording of vocalizations. Please note that these passive recorders will be installed at the beginning of the survey period and will only require minimal effort to maintain during the survey period (e.g., battery & SD card replacement).

Carcass Persistence and Searcher Efficiency Trials

(Not required but preferred, PV sites outside southwestern U.S.)

Searcher efficiency and carcass persistence are measured to adjust for detection bias in fatality studies (Huso et al. 2016). These bias adjustments may be modeled or extrapolated in regions where previous trials have been conducted at PV sites (e.g., Southwest). However, these trials should be completed outside the Southwest that have not yet been systematically monitored. Carcass persistence trials can be performed using chicken carcasses and wildlife cameras. Searcher efficiency trials will be conducted prior to surveys and can use surrogate carcasses (e.g., plush birds).

Calculation of Avian Mortality and Determination of Fatalities Mechanisms

In collaboration with experts, we will develop at least 2 working hypotheses that explain regional patterns and causes of avian fatality at PV sites, which will be reviewed annually based on evidence from the data collected for this project. We will review photos from wildlife camera traps deployed in the vicinity of fatality detections to determine whether predators may have interacted with the bird before or after the fatality event. In addition, the wildlife camera trap photos will be analyzed to characterize the abundance of predators on the site.

Avian Behavioral Analysis

We will quantitatively characterize bird behaviors (known as an ethogram analysis) at PV sites via interpretation of video recordings at partner PV sites for current study and the previous SETO-funded avian-solar technology development. From the hundreds of thousands of 5-minute video files, we will extract video files that contain birds by using the ML models developed for the previous project. We will interpret the behavior of each bird in the video and classify it into ecologically important categories, such as foraging, mating/breeding, nesting, self-maintenance, territoriality/aggression, and anti-predatory vigilance. We will also include behaviors indicating collision and stranding risks. We will analyze the interpreted bird behaviors by site, season, time of day, and taxonomic group (e.g., family or species) and determine spatiotemporal patterns of bird behaviors at PV sites.