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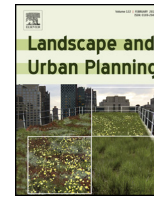

Research Paper

Bird use of solar photovoltaic installations at US airports: Implications for aviation safety

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HIGHLIGHTS

- Several airports have recently installed photovoltaic arrays on their properties.
- We studied bird use of photovoltaic arrays and airport grasslands in three states.
- Overall photovoltaic arrays did not increase bird hazards to aviation at airports.
- Large species hazardous to aviation were less abundant on photovoltaic arrays.

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ABSTRACT

Several airports in the US have recently installed large photovoltaic (PV) arrays near air-operations areas to offset energy demands, and the US Federal Aviation Administration has published guidelines for new solar installations on airport properties. Although an increased reliance on solar energy will likely benefit airports from environmental and economic perspectives, bird use of solar installations should be examined before wide-scale implementation to determine whether such changes in land use adversely affect aviation safety by increasing risk of bird-aircraft collisions. We studied bird use of five pairs of PV arrays and nearby airport grasslands in Arizona, Colorado, and Ohio, over one year. Across locations, we observed 46 species of birds in airfield grasslands compared to 37 species in PV arrays. We calculated a bird hazard index (BHI) based on the mean seasonal mass of birds per area surveyed. General linear model analysis indicated that BHI was influenced by season, with higher BHI in summer than fall and winter. We found no effect of treatment (PV arrays vs. airfields), location, or interactions among predictors. However, using a nonparametric two-group test across all seasons and locations, we found greater BHI in airfield grasslands than PV arrays for those species considered especially hazardous to aircraft (species ≥ 1.125 kg). Our results suggest that converting airport grasslands to PV arrays would not increase hazards associated with bird-aircraft collisions.

1. Introduction

The risk of wildlife-aircraft collisions is a substantial safety concern; such incidents annually cost civilian aviation at least $677 million in the US (Dolbeer, Wright, Weller, & Begier, 2011) and $1.2 billion worldwide (Allan, 2002). Ninety-seven percent of all wildlife strikes with aircraft are caused by birds, and over 70% of wildlife strikes occur in the airport environment (i.e., at or below 152 m above ground level; Dolbeer, 2006; Dolbeer et al., 2011). Thus, management practices that reduce bird abundance in and around airports are critical for aviation safety. Gulls (*Larus* spp.), waterfowl such as Canada geese (*Branta canadensis*), raptors (Falconiformes and Strigiformes), vultures (*Cathartes aura* and *Coragyps atratus*), and smaller birds that form large flocks such as blackbirds (Icteridae) and European starlings (*Sturnus vulgaris*) are high priorities for management at US airports (DeVault, Belant, Blackwell, & Seamans, 2011).

Many management techniques are available to reduce bird use of airports (Belant & Martin, 2011; DeVault, Blackwell, & Belant,

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2013), and are generally most effective when used in an integrated fashion (Conover, 2002). Even so, large-scale killing of wildlife is often undesirable or impractical (Dolbeer, 1986; Conover, 2002) and nonlethal frightening techniques (e.g., pyrotechnics) can be cost-prohibitive or only temporarily effective (Baxter & Allan, 2008). Habitat management is the most important long-term component of an integrated wildlife management approach to reduce use of airfields by birds and other wildlife that pose hazards to aviation (Blackwell, DeVault, Fernández-Juricic, & Dolbeer, 2009; DeVault et al., 2011).

Habitat composition at airports depends on air-operations safety regulations, economic considerations, and wildlife management (Federal Aviation Administration, 1989, 2007). Land cover should prevent soil erosion, minimize blowing dust and debris, and require little maintenance. Wildlife managers must work under these constraints when contemplating habitat types that will not attract hazardous wildlife. Historically, the principal land cover at airports has been turf grass. However, large expanses of turf grass can attract hazardous bird species (e.g., Canada geese), and there is no consensus regarding the species composition and height of turf grass that best reduces bird hazards at airports (Blackwell et al., 2013). Regardless of species composition and height, turf grass is expensive for airports to maintain (Washburn & Seamans, 2007), and other potential land covers should be explored from a wildlife perspective to identify safe alternatives (Blackwell et al., 2009; DeVault, Begier et al., 2013; Martin et al., 2011).

A recent study estimated that airports in the contiguous US collectively contain over 3300 km^2 of undeveloped grasslands (DeVault et al., 2012). These authors suggested that with careful planning much of that area could potentially be converted to alternative energy production. Increased reliance on alternative energy would be environmentally and economically beneficial for airports (DeVault et al., 2012; Federal Aviation Administration, 2010; Infanger, 2010). Further, although accelerated development of alternative energy production has generated concerns such as reductions in wildlife habitat and competition with human food production (Cho, 2010; Fargione et al., 2009; Lovich & Ennen, 2011, 2013; McDonald, Fargione, Kiesecker, Miller, & Powell, 2009), airport lands are mostly unsuitable for wildlife conservation and commodity production due to the increased risk of wildlife-aircraft collisions associated with these land uses (Blackwell et al., 2013; Federal Aviation Administration, 2007; International Civil Aviation Organization, 2002; Martin et al., 2013). Thus, in some respects airports appear well suited for establishment of new alternative energy production facilities.

One type of alternative energy clearly gaining momentum for wide-scale implementation on airport properties is solar photovoltaic (PV) energy production. The Federal Aviation Administration recently published guidance on establishment of new PV installations at US airports (Federal Aviation Administration, 2010), and multiple airports throughout the US have already installed large PV arrays on their properties and others are in the planning phases (DeVault et al., 2012). In the airport context, PV arrays generally pose fewer potential direct hazards (e.g., penetration of airspace, glare, thermal plume turbulence) than other renewable energy technologies such as wind turbines and concentrating solar power plants (Barrett & DeVita, 2011; but see Wybo, 2013). However, despite the apparent benefits of siting PV arrays on airport properties, it is unclear how this type of land use influences bird communities on and around airports.

Photovoltaic arrays could potentially serve as attractants to birds hazardous to aviation because they provide shade and perches for birds, both of which are limited in grassland-dominated airport environments (DeVault, Kubel, Rhodes, & Dolbeer, 2009; DeVault et al., 2012). Dark glass panels such as those used to construct PV arrays also reflect polarized light, which can attract insects (Horváth, Kriska, Malik, & Robertson, 2009), and subsequently, insectivorous birds. Further, in some situations reflected polarized light may cause structures such as glass panels to be mistaken by some birds species for open water, resulting in mortalities from collisions with these structures or being stranded on surfaces from which they cannot take off (Horváth et al., 2009). However, despite this potential mortality, PV arrays are in use at US airports and there is no measure of relative hazards of these facilities to aviation safety.

Before consideration of wide-scale conversion of airport grasslands to PV arrays, the effects of this land-use change on local bird communities should be assessed (Wybo, 2013). Our purpose was to compare bird use of PV arrays to that of nearby airfield grasslands to determine whether PV arrays receive greater use by birds hazardous to aircraft and, thereby, adversely affect aviation safety. We predicted, however, that because solar development is generally considered detrimental to wildlife (Lovich & Ennen, 2011), and airfield grasslands are recognized as attractants to some birds because of food and cover resources (e.g., Blackwell et al., 2013; DeVault, Begier et al., 2013; Martin et al., 2011), airfields would receive greater use than PV arrays by birds recognized as hazardous to aviation safety.

2. Materials and methods

2.1. Study areas

We selected five locations in the US where PV arrays were close (<20 km) to airfields: one in western Ohio (Wyandot), two in the high plains of Colorado (Denver and Ft. Collins), and two in the Arizona mountains (Prescott and Springerville). Each location consisted of an airfield–PV array pair for a total of 10 study sites. We assumed that each airfield–PV array pair potentially could contain the same bird communities, thus controlling for regional differences in species ranges. The Wyandot location consisted of the Seneca County airport (53 ha; Lat 41.015940° Lon −83.666937°) and the Wyandot solar farm (25 ha; Lat 40.880371° Lon −83.314550°). The Denver International Airport (13,540 ha; Lat 39.847135° Lon −104.617471°), which contained a solar farm (8 ha) on the airport property, comprised the Denver location. The Ft. Collins–Loveland Municipal Airport (431 ha; Lat 40.446326° Lon −104.988595°), and the Colorado State University Foothills Campus Chrisman Field Solar Plant (10 ha; Lat 40.592424° Lon −105.143371°) comprised the Ft. Collins location. The two Arizona locations were the Ernest A. Love Field (308 ha; Lat 34.656422° Lon −112.395996°) paired with the APS/SunEdison Prescott Solar Plant (7 ha; Lat 34.678777° Lon −112.382669°), and the Springerville Municipal Airport (202 ha; Lat 34.127900° Lon −109.287717°) paired with the Springerville Generating Station Solar Farm (17 ha; Lat 34.298483° Lon −109.258976°).

The airfields in Arizona and Colorado were typically mowed once per year and the Ohio airfield was mowed multiple times during the growing season. Mean vegetation height at airfields during March–May, June–August, September–November, and December–February was 20.3, 32.0, 33.5, and 23.1 cm, respectively. Mean vegetation height at PV arrays was less: 8.7, 21.0, 9.6, and 5.9 cm, respectively. Ground cover at airfields comprised a high proportion of grasses, with scattered forbs and legumes. At Denver and Prescott, ground cover at PV arrays was generally gravelled with very sparse vegetation. At Wyandot, Ft. Collins, and Springerville, PV arrays were composed of a high proportion of grasses with a small proportion of forbs, similar to their paired airfield sites. Although vegetation differed between airfield grasslands and PV arrays, our intent was to evaluate bird use of established PV facilities, not to evaluate direct effects of PV panels themselves or differentiate effects of PV panels and vegetation composition