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Use of stormwater impoundments near airports by birds recognized as hazardous to aviation safety

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HIGHLIGHTS

- Stormwater sites near airports attract birds hazardous to aviation safety.
- We modeled use of stormwater sites by birds involved in bird–aircraft collisions.
- Site features affecting cover and foraging contributed positively to use by birds.
- Design and management reducing water and cover availability can enhance safety.

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ABSTRACT

Design of privately-owned stormwater impoundments within or near airport siting criteria has received little attention with regard to potential hazards posed to aviation safety. In particular, minimizing use of these impoundments by bird species recognized as hazardous to aviation poses an important challenge. Emergent vegetation, shoreline irregularity, and proximity of other water resources are linked to avian richness and diversity within wetlands, as well as bird use of stormwater impoundments on airports. We predicted also that impoundments with bank slope >20% and those functioning as detention facilities, where water is periodically drawn down, would negatively influence use by birds; and that shoreline-vegetation diversity and local land-use diversity would be positively correlated with use. Over 104 weeks (March 2008 to March 2010), we surveyed bird use of 40 stormwater impoundments in the Auburn-Opelika Metropolitan area, Lee County, AL, USA, typical of privately-owned facilities located within or near airport siting criteria. We quantified local-scale and site-specific parameters possibly affecting bird use and evaluated fit for 17 *a priori* models relative to detection of 10 individual avian foraging guilds recognized as hazardous to aviation safety. Relative likelihoods of best-approximating models (Akaike weights) ranged from approximately 0.42 to 0.92. Based on best-approximating models for at least five of the 10 guilds, we suggest that broad reduction in use of stormwater impoundments, located within or near airport siting criteria, by bird species hazardous to aviation can be achieved via designs which minimize perimeter, surface area, and the ratio of open water to emergent vegetation.
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1. Introduction

Collisions between wildlife and aircraft are a growing threat to civil aviation safety (Dolbeer, 2011). Of these wildlife strikes, bird–aircraft collisions (hereafter "bird strikes") are by far the greatest concern because of strike frequency and associated damage (DeVault, Belant, Blackwell, & Seamans, 2011; Dolbeer, 2011). In the USA alone bird strikes to civil aviation result in industry losses exceeding US$ 600 million annually (Dolbeer, Wright, Weller, & Beiger, 2012), and over US$ 1.2 billion annually worldwide (Allan, 2002). Dolbeer (2006) reported that 74% of bird strikes occur at <152 m (500 ft) above ground level (AGL), airspace within an airport's air operations area (AOA; US Federal Aviation Administration, FAA, 2007), or in close proximity. The AOA encompasses all surface areas designed for aircraft movement including runways, taxiways and aprons. An underlying assumption regarding strikes within the AOA is that birds are attracted by habitat characteristics

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or resources in the immediate vicinity of the collision (Blackwell, DeVault, Fernández-Juricic, & Dolbeer, 2009; Cleary & Dolbeer, 2005). Therefore, bird strike-prevention efforts focus primarily on airport properties (Dolbeer, 2011), but management of wildlife attractants on adjoining properties is also important (Blackwell et al., 2009; DeVault et al., 2012; Martin et al., 2011).

In the USA, the FAA is responsible for advising airport managers and other stakeholders on managing attractants to potentially hazardous wildlife, and exerts regulatory control over airport certification and operation via Title 14 Code of Federal Regulations (CFR), Federal Aviation Regulations, Part 139—*Certification of Airports.* Specifically, the FAA (2007) instructs airport managers to address, and if possible eliminate, wildlife attractants within 1.5 km of the AOA for airports serving piston-powered aircraft and 3.0 km for airports serving turbine-powered aircraft. Notably, aircraft descending on a 3° glideslope would be ≤152 m AGL at 3 km from the runway (Flight Safety Foundation, 2000), thus within the FAA siting criterion. However, the FAA and airports have limited regulatory roles over land uses off of airport property (including private property within siting criteria; Blackwell et al., 2009; DeVault et al., 2012).

Water resources within and near the AOA pose particular concerns because a variety of avian genera recognized as hazardous to aviation utilize open water (DeVault et al., 2011). Specifically, 13 of 52 (25%) avian species involved in at least 50 total strikes reported to the FAA (1990–2008; summarized in the FAA Wildlife Strike Database; http://wildlife-mitigation.tc.faa.gov/wildlife/) have foraging and breeding ecologies primarily associated with water (Blackwell et al., 2013). Further, an analysis of water coverage at 49 CFR-Part 139 certificated airports revealed that surface water composed on average 6.0% (SD = 10.4%; range: 0.04–48.3%) of the area ($\bar{X}$ area = 275 ha, SD = 511 ha) within the 3-km FAA siting criteria (Appendix A). Stormwater impoundments are constructed in and around airports to ensure environmental compliance with regard to water quality (http://www.faa.gov/airports/environmental/environmental_desk_ref/media/desk_ref_chap6.pdf; see also Baier et al., 2003), as well as aircraft safety relative to redirecting runoff away from the AOA. However, these impoundments also serve to create wildlife habitat by providing standing water after storm or runoff events (Blackwell, Schafer, Helon, & Linnell, 2008) or deicing operations (Airport Cooperative Research Program, 2009). Impoundments that do not drain completely can develop sediment deposits and vegetation complexes over time that support an array of invertebrate and vertebrate diversity (Brand & Snodgrass, 2009; Le Viol, Mocq, Julliard, & Kebiriou, 2009), thus offering potential foraging, loafing, roosting, and nesting space to a variety of bird species (e.g., Blackwell et al., 2008; Le Viol et al., 2009; Sparling, Eisemann, & Kuenzel, 2007).

Unfortunately, the majority of research on bird use of stormwater impoundments has focused primarily on efforts to enhance these facilities as attractants (e.g., Adams, Dove, & Franklin, 1985; Duffield, 1986; Sparling, Eisemann, & Kuenzel, 2004; Sparling et al., 2007; see also Murray & Hamilton, 2010; White & Main, 2005). Far less effort has focused on understanding bird use of stormwater impoundments so as to reduce use by birds recognized by the FAA as posing hazards to aviation safety (e.g., Blackwell et al., 2008, 2009). For example, Blackwell et al. (2008) suggested that designs for on-airport stormwater impoundments in the Pacific Northwest, USA, should minimize perimeter and be located so as to reduce the number and proximity of other water resources within 1 km. However, inherent to airport stormwater impoundments is some degree of post-construction management, regulated by the FAA, that can serve to reduce use by birds and other wildlife.

Our purpose was to better understand avian use of stormwater impoundments that are not regulated by the FAA, but typical of facilities that are found within or near airport siting criteria.

Table 1
Parameters pertaining to bird use of natural and man-made water resources and selected to compose 17 a *priori* models (see Table 2 developed to describe use of 40 stormwater impoundments in the Auburn-Opelika Metropolitan area, Lee County, AL, USA, by avian guilds recognized as hazardous to aviation safety (DeVault et al., 2011).

Co-variate	Source
Impoundment design (retention vs. detention)	Steen et al. (2006)
Surface area	Adams et al. (1985), Blackwell et al. (2008), Brown and Dinsmore (1986), Carbaugh et al. (2010)
Shoreline irregularity	Blackwell et al. (2008, and citations therein); Cicero (1989)
Ratio of proportion of open water to emergent vegetation	Blackwell et al. (2008); Duffield (1986); Hobaugh and Teer (1981); Weller and Spatcher (1965)
Isolation relative to area of other open-water resources within a defined radius	Brown and Dinsmore (1986); Blackwell et al. (2008); Duffield (1986); Dunton and Combs (2010)
Bank slope	DeGraaf et al. (1985); Duffield (1986); FAA AC 150/5200-33B
Vegetation diversity	Bancroft et al. (2002); Cicero (1989); Steen et al. (2006)
Land-use diversity	Blair (1996); Dykstra et al. (2001); Stout et al. (2006); Traut and Hostetler (2003)
Seasonal influences	Caula, Marty, and Martin (2008)

Emergent vegetation, shoreline irregularity, and proximity of other water resources are linked to avian richness and diversity within wetlands, as well as bird use of stormwater impoundments characteristic of FAA-regulated facilities on airports (Table 1). In addition to these factors, we predicted that impoundments with bank slopes >20% and those functioning as detention facilities, where water is periodically drawn down, would negatively influence use by birds; and that shoreline-vegetation diversity and local land-use diversity would be positively correlated with use. Our specific objectives were to (1) quantify local-level features, as well as site-specific characteristics associated with privately-owned stormwater impoundments, within or near airport siting criteria, that might serve as bird attractants; and (2) make recommendations as to design of stormwater impoundments near airports to reduce attraction to birds recognized as hazardous to aviation.

2. Materials and methods

2.1. Study area

We conducted our study in the Auburn-Opelika Metropolitan area in Lee County, AL, USA, from March 2008 to March 2010 (Fig. 1). This region includes remnant tracts of longleaf pine (*Pinus palustris*), but much of this area has been converted to agriculture, timber production, or urban development (Commission for Environmental Cooperation, 1997).

2.2. Impoundment selection

We selected 40 stormwater impoundments (Fig. 1) to serve as surrogates for unregulated (by the FAA) impoundments that could be located within or near the 3-km siting criterion (FAA, 2007). These surrogate impoundments were generally located within approximately 5 km (10 sites within 10 km) of a regional airport (Fig. 1), had characteristics typical to all stormwater impoundments, but were not all characteristic of FAA (2007) design and management recommendations (i.e., they included unmanaged or more natural shorelines). All sites contained inlet and outflow pipes, rip–rap areas and spillways, features common to stormwater impoundments in AL (Baier et al., 2003). In addition, all sites