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Conclusions and Future Directions

Jerrold L. Belant
USDA/APHIS/WS National Wildlife Research Center

Travis L. DeVault
USDA/APHIS/WS National Wildlife Research Center, Travis.L.DeVault@aphis.usda.gov

Bradley F. Blackwell
USDA/APHIS/WS National Wildlife Research Center, bradley.f.blackwell@aphis.usda.gov

15 Conclusions and Future Directions

Jerrold L. Belant
Travis L. DeVault
Bradley F. Blackwell

Although the management of wildlife at airports has seen great progress in recent decades, wildlife collisions with aircraft continue to pose risks to human safety and economic losses to the aviation industry and military (Allan 2002, Dolbeer 2009). Our understanding of physiological and behavioral responses of wildlife to various types of repellents and harassment techniques has grown tremendously. Substantial inroads have been made in developing and optimizing exclusion devices, particularly for mammals. Research and management have increased considerably in recent years, allowing us to better understand aspects of resource use (e.g., cover, food) by wildlife and the spatial scales at which they operate (Martin et al. 2011), as well as to improve current management strategies. We suggest that these two forms of management—repellents and harassment (e.g., Chapters 2–4) and habitat management (e.g., Chapters 8–11)—should be integrated to reduce hazardous wildlife use of airports. Direct control methods (e.g., hazing) typically work only in the short term; reducing habitat suitability for wildlife at airports will likely enhance long-term efficacy of these techniques.

As the integration of several control techniques can result in marked reductions of wildlife use at airports compared to using individual control techniques (see Conover 2002), our improved understanding of ecological theory related to wildlife use of these areas also can enhance our ability to manage associated wildlife risks. Understanding the mechanisms, or causes, of wildlife use of areas at and near airports allows us to better manage potential hazards. This fundamental mechanistic understanding results in more accurate selection of management options and long-term efficacy of management, which reduces its overall costs. To re-emphasize a simple but effective example, consider a situation described by Bernhardt et al. (2009), who noted comparatively high rates of aircraft collisions with tree swallows (*Tachycineta bicolor*) during autumn at John F. Kennedy International Airport, New York, New York, USA. Rather than increasing harassment actions each autumn to disperse the swallows, airport personnel conducted a study on food resources (Chapter 8) and found that their diet consisted predominantly of northern bayberry fruit (*Myrica pensylvanica*). Determined to be the mechanism or cause of the problem, the bayberry shrubs were subsequently removed. Aircraft strikes with swallows declined markedly in years following bayberry removal, which resulted in reduced hazards to aircraft and allowed airport biologists to focus on other issues.

Although considerable progress has been made in reducing wildlife hazards to aircraft, several important needs for additional information remain. There is need for better understanding of which wildlife species collide most often with aircraft. In the USA, reporting wildlife–civil aircraft strikes to the Federal Aviation Administration (FAA) is voluntary (Cleary and Dolbeer 2005). Heightened public awareness of wildlife collisions with aircraft increased following the crash of US Airways Flight 1549 into the Hudson River (Marra et al. 2009), which in turn increased reporting rates, but only an estimated 39% of all strikes with U.S.-registered aircraft are reported to the FAA (Dolbeer 2009). In addition, only about 26% of reports of wildlife strikes with civil aircraft identify the species involved (Dolbeer and Wright 2009). An improved understanding of the species involved in aircraft collisions could advance our knowledge of those most hazardous to aircraft, as well as strike timing and areas of greatest risk. This knowledge could then help inform airport biologists and contribute to regional- or national-level assessments of risk.

Standardization of survey and monitoring techniques is similarly necessary to ensure consistency in data collection and to allow comparison of hazards at a given airport over seasons or years, as well as to compare relative hazards among airports. In the USA, passenger-certificated airports that experience wildlife hazards are required by the FAA to obtain a Wildlife Hazard Assessment, followed by implementation of a Wildlife Hazard Management Plan (Dolbeer and Wright 2009). Chapter 14 provides a framework that modifies common bird survey approaches to facilitate standardization of data collected within and across airports. One advantage of this approach is the ability to estimate relative species abundance by incorporating imperfect detection of individuals (e.g., MacKenzie 2005). Such standardization and objective-driven data collection can facilitate the development of spatially explicit risk models for airports. Monitoring wildlife use of airports in this manner can improve our ability to discern the best management approaches and to assess the effects of management practices.

An important research emphasis is the development of improved models for estimating risk associated with aircraft collisions, especially for birds. A number of models have been developed in recent years in an effort to quantify risk (Allan 2006; Schafer et al. 2007; Soldatini et al. 2010, 2011). Each of these models in various forms integrates some element of species' relative hazard to aircraft (DeVault et al. 2011), often based in part on body mass (e.g., Allan 2006), as well as abundance and distributions of wildlife species at and near airports. These models are an important step toward assessing wildlife hazards to aircraft, although they pose one apparent disadvantage—they are generally linked to the entire airport and do not adequately consider potential variation in wildlife use of space. Some models (e.g., Soldatini et al. 2011) consider temporal variation in wildlife hazards, however. Birds typically move in three-dimensional space across time; the importance of considering their altitudinal flight behavior has long been recognized (Major and Dill 1978, DeVault et al. 2005, Avery et al. 2011) and can markedly affect collision rates with aircraft (e.g., Dolbeer 2006). The development of three-dimensional models of birds' probabilistic use of space in relation to aircraft would be a major advancement in risk assessment (Schafer et al. 2007, Belant et al. 2012). For example, habitats surrounding approach and takeoff routes for some airports could be modified on the basis of estimated occurrence of hazardous birds to reduce the probability of collisions.

Advancements in wildlife management at airports have certainly resulted in a reduction of hazardous wildlife at airports (Dolbeer 2011); however, continued and improved efforts are required to minimize suitability of habitats at airports and surrounding areas to wildlife. By continuing to integrate multiple techniques based on the principles of wildlife ecology, and by incorporating technologies that improve our understanding of wildlife and the hazards they pose to aircraft, we can continue to reduce the potential risk of wildlife incidents with aircraft. We cannot ignore new technologies and practices that limit resource availability to wildlife using airports (e.g., DeVault et al. 2012; Chapters 10 and 11). Integration of science with management, through application of new knowledge into airport-specific and national-level guidelines, will further improve the safety of air passengers and reduce economic and biological losses.

Airport managers have long recognized the need and potential advantages of incorporating multiple uses at airports (Infanger 2010), including improved public perception, environmental friendliness (e.g., reducing carbon footprint), and economic incentives. Conserving grassland bird species may be appropriate for some airports (Kelly and Allan 2006), but a lack of scientific data precludes the development of management strategies to conserve grassland birds appropriate for airports (Blackwell et al. 2013). Similarly, increasing global energy demand has resulted in myriad new technologies and applications of alternative energy sources. Although energy production is typically detrimental to wildlife, airports offer one of the few socially acceptable land uses where wildlife use is generally discouraged. Consequently, recent progress has been made in assessing and developing alternative energy sources at airports, especially solar energy (FAA 2010, Infanger 2010, DeVault et al. 2012). Herbaceous biofuels also have potential application at airports, but wildlife use of these plantings and the associated risk to aircraft is less understood than other alternative energy sources (DeVault et al. 2012; Chapter 11).

Integrating management methods that effectively exploit animal sensory capabilities and behaviors, use of resources, movement patterns, and other aspects of animal ecology is vital for reducing wildlife risks to aviation. With an improved understanding of ecological theory and principles as related to wildlife use of airports, airport managers and wildlife biologists can further reduce the number of wildlife–aircraft collisions. It is our hope that this book has provided the basis for such an understanding, and that it will contribute to successful management of wildlife at and near airports worldwide.

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