A Review of Wildlife Hazard Mitigation Techniques on General Aviation Airports

Robert J. Lewis
Murray State University, Department of Biological Sciences, 2112 Biology Building, Murray, KY 42071, USA.

Joe N. Caudell
Murray State University, Department of Biological Sciences, 2112 Biology Building, Murray, KY 42071, USA.

ABSTRACT: Large commercial airports, also known as Part 139 airports, are required by federal regulation to monitor and control wildlife activity. Due to the regulatory nature of 14 Code of Federal Regulation (CFR) Part 139.337, and the size and scope of these airports, there is sufficient funding to support wildlife management. However, in the United States, there are an additional 19,000 landing facilities, of which 4,600 are known as public use, general aviation airports. These general aviation airports are not bound by any regulation to mitigate wildlife hazards at their facilities; however, at least 33.9% of these airports have known wildlife hazards. Due to their small and often non-commercial nature, general aviation airports have limited operational budgets and often must solve wildlife hazards with existing personnel. Because these personnel are often not trained in wildlife management techniques, they may be unaware of suitable options for controlling wildlife damage. Therefore, we reviewed existing wildlife damage management techniques that are commonly used at Part 139 airports and surveyed airport wildlife damage management professionals to assess the techniques for use at general aviation airports based on the initial costs of implementation; the amount of training required to implement the techniques; perpetual costs; and the amount of man hours per week required to implement the technique. All techniques were scored on a 5-point scale for each category, resulting in a composite score. This review may serve as a guide in the decision making process for general aviation airport managers when considering wildlife management at their airports.

Key Words: airport, bird strike, cost, damage management, GA, general aviation, mitigation, survey, wildlife strike

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INTRODUCTION

Since the first flight of an airplane by Wilbur and Orville Wright in 1903, air transit has become an integral part of the global economy, generating billions of dollars annually. The first bird strike, a red-winged blackbird (*Agelaius phoeniceus*), was recorded by the Wright brothers in 1905. The first human fatality as a result of a bird strike (gull sp. [Laridae]) was recorded in 1912 (DeVault et al. 2013). Over time, the annual number of aircraft operations has increased and aircraft have become faster and quieter (DeVault et al. 2013). The combination of these factors has resulted in an increase in the number of wildlife strikes. Following the implementation of electronic

reporting methods, the number of wildlife strike reports has risen. Of the 142,603 strike reports filed between 1990 and 2013 (a 24 year period), 11,315 (8%) were filed in 2013. The number of strikes filed in 2013 is 611% higher than the number filed in 1990 (FAA 2014). These strikes caused damage totaling $103 million in 2013 to commercial aircraft in the United States alone. It is estimated that at least $937 million have been lost since 1990 due to wildlife strikes (FAA 2014). These figures do not take into account monetary losses due to labor costs or flight schedule changes (USDA 2005). Monetary losses aside, wildlife strikes to aircraft can also be deadly, with 255 individuals killed in the United States since 1988 (FAA 2014).

Because of the risk to human life and the potential of negative economic impact, much research has been undertaken in various disciplines to manage wildlife in and around airports, with the primary goal of minimizing the risk posed by wildlife to aircraft and their contents. The existence of the United States Department of Agriculture, Animal and Plant Health Inspection Service (USDA APHIS) Wildlife Services National Wildlife Research Center (NWRC) facility dedicated to researching wildlife hazards to aircraft indicates the importance of this type of research. The studies conducted by the NWRC and others include landscape level planning (Blackwell et al. 2009), habitat manipulation (Blackwell et al. 2008), the deterrence of a particular species of concern or even individual animals (York et al. 2000), and other avenues of research. This research has led to the development of a variety of methods used to mitigate wildlife damage at airports during the past 50 years. To address wildlife strike hazards, each airport must be evaluated separately for wildlife habitat, species present, and the flight operations characteristic of the airport. Because of the unique characteristics of each airport, there is no standard wildlife management plan that can be implemented. Each technique that is to be used must be evaluated by airport wildlife managers for its efficacy, environmental impact, impact on flight safety, and human dimensions (Cleary and Dolbeer 2005). Detailed descriptions of, and instructions on, the proper implementation of these methods are available from many sources including the Federal Aviation Administration (FAA [Cleary and Dolbeer 2005]), the Airport Cooperative Research Program (ACRP [ACRP 2010]), and branches of the Department of Defense (U.S. Air Force 2004, Commander, Naval Installations Command 2010). However, many of these guides are designed for larger airports that can train and employ full-time personnel or contract with wildlife biologists to control wildlife on a regular basis.

In the United States, all airports serving regularly scheduled passenger-carrying operations with aircraft designed with more than 9 passenger seats, or unscheduled passenger-carrying operations of aircraft with 31 or more seats, are governed by 14 Code of Federal Regulation (CFR) Part 139. The regulations in 14 CFR Part 139, among others, set standards for firefighting equipment, airport signage, security procedures, and also require that airports certificated under 14 CFR Part 139 mitigate wildlife hazards to aviation safety as they become known.

14 CFR Part 139.337(a): In accordance with its Airport Certification Manual and the requirements of this section, each certificate holder must take immediate action to alleviate wildlife hazards whenever they are detected.

As of 30 July 2014, there were 542 airports that operated under 14 CFR Part 139 (referred to as Part 139 airports).

With this legal mandate, many of these airports have extensive wildlife management departments consisting of either trained airport personnel or contracted entities. Regardless of who conducts wildlife management on Part 139 airports, if certain wildlife hazard conditions are met, a wildlife damage biologist, having professional training in wildlife hazard management at airports, or their designee must complete a wildlife hazard assessment (14 CFR Part 139.337). Due to the regulatory nature of 14 CFR Part 139, airport managers provide funding to conduct wildlife management and wildlife hazard mitigation. However, in the United States, there are an additional 19,000 landing facilities (e.g. heliports, seaplane bases, and runways), of which 4,610 are public use, general aviation airports, seaplane bases, glider bases, balloon ports, ultralight ports, or heliports (hereafter referred to as general aviation [GA]

airports)(FAA 2015). These GA airports are not bound by any regulation to mitigate wildlife hazards at their facilities; however, many of these airports have known wildlife hazards.

Due to their small, often non-commercial nature, GA airports have limited operational budgets, frequently comprised of funds allocated by local municipalities and funding from the United States Department of Transportation (ACRP 2010). These GA airports often have limited staffing (ACRP 2010). It is not uncommon for the airport manager to be the sole employee of the airport. Therefore, that sole employee is often tasked with keeping facilities in working order, maintaining the airport, and conducting traditional managerial activities. Many general aviation airports are often located in rural areas rather than in metropolitan areas, as are many Part 139 airports (ACRP 2010). This factor regularly places airports in close proximity to agriculture, timber production, landfills, and protected natural areas (ACRP 2010). All of these neighboring land uses frequently are associated with wildlife, thereby contributing to wildlife hazards on rural airfields (Cleary and Dolbeer 2005).

In addition to being rural, many GA airports have a low operational tempo. They may only see a few flight operations each day. This low tempo creates a situation where wildlife are not habituated to avoiding areas adjacent to aircraft movement surfaces. General aviation airports are often characterized by the types of aircraft they service: mostly piston-powered light aircraft. Many light aircraft are not hardened against wildlife strikes, like commercial aircraft, since they are not mandated to be so under 14 CFR Part 25. As such, what might be a relatively minor strike to the windscreen, engine, or control surface of a commercial aircraft could be catastrophic to a light aircraft. Though strikes to GA aircraft comprised only 15% of the total number of reported strikes in 2013, the true number of strikes is likely much higher since strike reporting is not mandatory and is not widely practiced in the GA community, likely due to the fact that knowledge of wildlife strike reporting is not required on the FAA recreational pilot or private pilot written tests. (FAA 2014, FAA 2015). There are no data available detailing the prevalence of wildlife hazards, or the species that pose those hazards at GA airports.

Because these GA airports are often lacking in funding, they often attempt to control wildlife using existing personnel. Smaller airports with more limited resources are often not considered when developing manuals or other materials that provide guidance to airport managers. Though there is 1 manual written for GA airport wildlife management (ACRP 2010), there is still a large knowledge gap between GA airport managers and professional airport biologists who are legally required to conduct wildlife hazard assessments and are commonly employed at Part 139 airports. Oftentimes, GA airport managers are frequently left to their own knowledge when examining the feasibility of beginning a wildlife damage management program at their airfield. This may result in inefficient allocation of resources, inefficient wildlife management, and frustration by the airport manager. This may also result in airport managers implementing unsafe, harmful, or even illegal wildlife management methods.

METHODS

To determine how widespread wildlife conflicts were at GA airports, we obtained a spreadsheet of all public use landing facilities in the United States from the FAA website. We removed all Part 139 airports from the list, leaving only GA landing facilities. We also removed balloon ports, glider ports, and ultra-light ports, as they comprised 0.2% of GA landing facilities. We assigned all remaining facilities an identification number from 1 to 4,600. We used a random integer generator to generate 463 random integers between 1 and 4,600. According to Bartlett et al. (2001), for categorical data with a population of approximately 4,000 and a margin of error of 0.05, we would require a sample size of at least 351 airports to have a representative sample of GA airports. We manually searched for each facility corresponding with a generated random integer in the Aircraft Owner's and Pilot's Association (AOPA) Airports online database and assessed whether any remark for wildlife hazards existed. We used the AOPA Airports online database because it compiles aeronautical information from multiple FAA sources and is

updated on the FAA update cycles (AOPA We categorized wildlife hazard remarks as warning of waterfowl, birds (not specifying any guild), deer, swine, elk, antelope, gulls, coyotes, cervids (as a guild), or a generic wildlife hazard remark. We then separated landing facilities by type into 3 categories, seaplane base, heliport, and airport), and analyzed the rate of wildlife hazard remarks between types of landing facilities.

To determine what airport biologists would typically choose to use at these non-Part 139 airports, we created a SurveyMonkey® poll that listed wildlife hazard mitigation techniques that were commonly implemented at Part 139 airports which was distributed in the Wildlife Damage Working Group through their quarterly newsletter, *Interactions* (Lewis 2015) and to Wildlife Services biologists who routinely work at airports. We asked respondents to assess each technique for initial procurement costs, training time and costs, amount of time required per week to properly implement the strategy, and the recurring costs of maintenance and expendables using a Likert scale. Respondents were instructed to evaluate only the methods that they were familiar with. Each category was given a score from 0 to 5, representing no costs, nominal costs, low costs, moderate costs, high costs, and prohibitive costs, under normal funding circumstances, respectively. We defined each score as follows, and gave no further guidance on the scores:

0 (None): No cost/time

1 (Nominal): Very low cost/time

2 (Low): Limited cost/time that can be committed with little consideration.

3 (Moderate): Cost/time investment that must be considered. Not insignificant.

4 (High): Cost/time investment that must be carefully weighed.

5 (Prohibitive under normal circumstances): Cost/time investment that is beyond the normal scope of operations for an airport.

The scores for each category were summed, resulting in a composite score.

The Murray State University Institutional Review Board (MSU IRB) was consulted prior to distribution of our survey. They found that this was not human research and thus did not require MSU IRB permission.

RESULTS

Of the GA landing facilities that were searched (n=463), 33.9% (n=157) had a wildlife hazard remark in AOPA Airports. When analyzed by landing facility, 35.4% of airports (153/432), 16.7% of seaplane bases (4/24), and 0% of heliports (0/7) had “wildlife hazard” remarks.

We found that 30% of all sampled airports that reported a wildlife hazard, reported more than 1 species or guild as presenting a hazard at that airport. We also found that deer (51.6%) were the most common animal or guild identified and reported as a hazard at airports, followed by birds (31.9%), and a general wildlife hazard remark (21.7%) (Table 1).

We found that snag removal and manual harassment had the lowest composite scores (5.6 and 6.3, respectively) while trained raptors and avian radar had the highest composite scores (14.3 and 15.5, respectively) (Fig. 1 and Fig. 2)

Figure 1: The results of a 2015 survey of 17 professional airport wildlife biologists asked to evaluate the costs associated with implementing various airport wildlife damage management techniques with 95% confidence interval bars show.

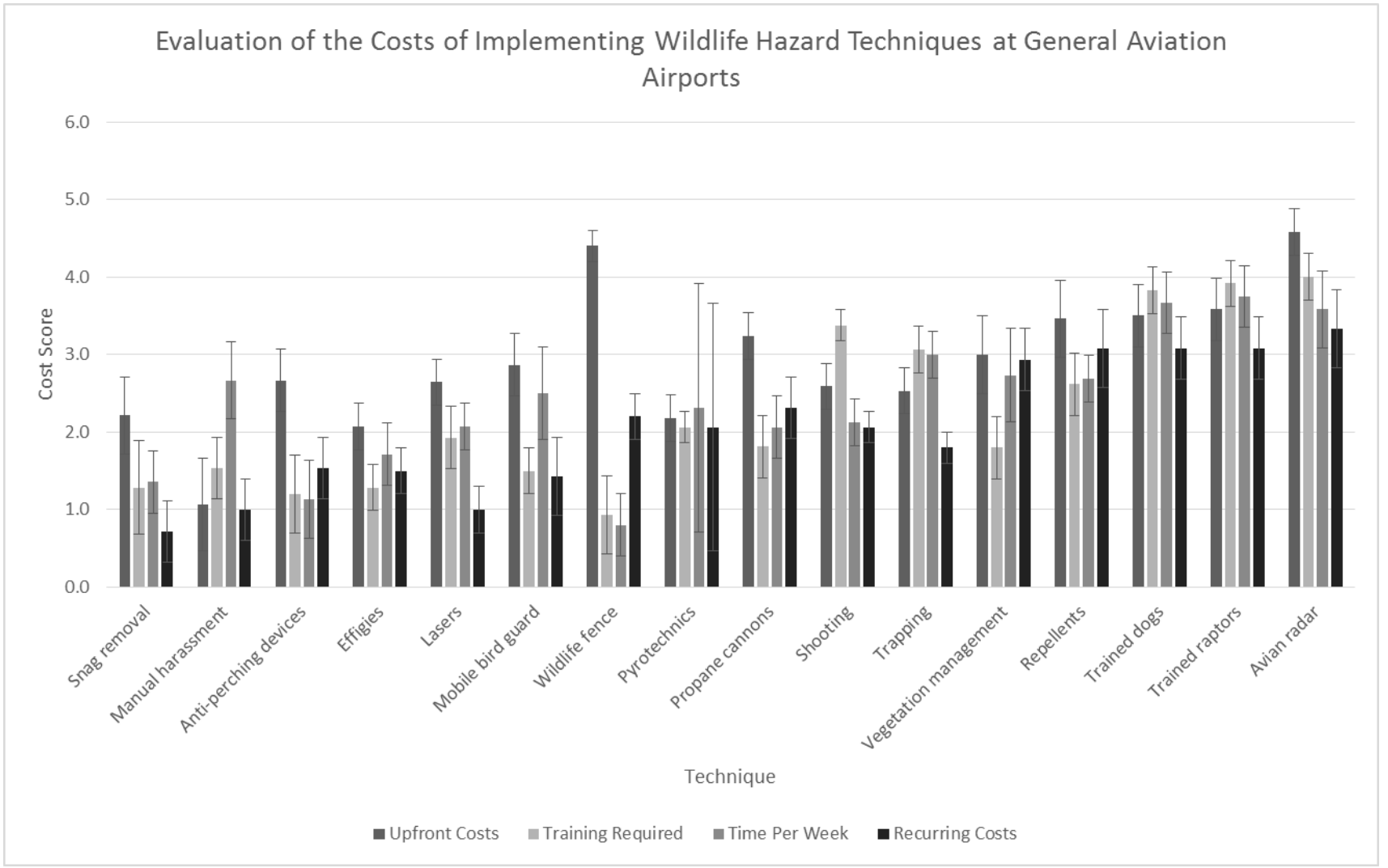

Figure 2: Composite scores of a 2015 survey of 17 professional airport wildlife biologists asked to evaluate the costs associated with implementing various airport wildlife damage management techniques.

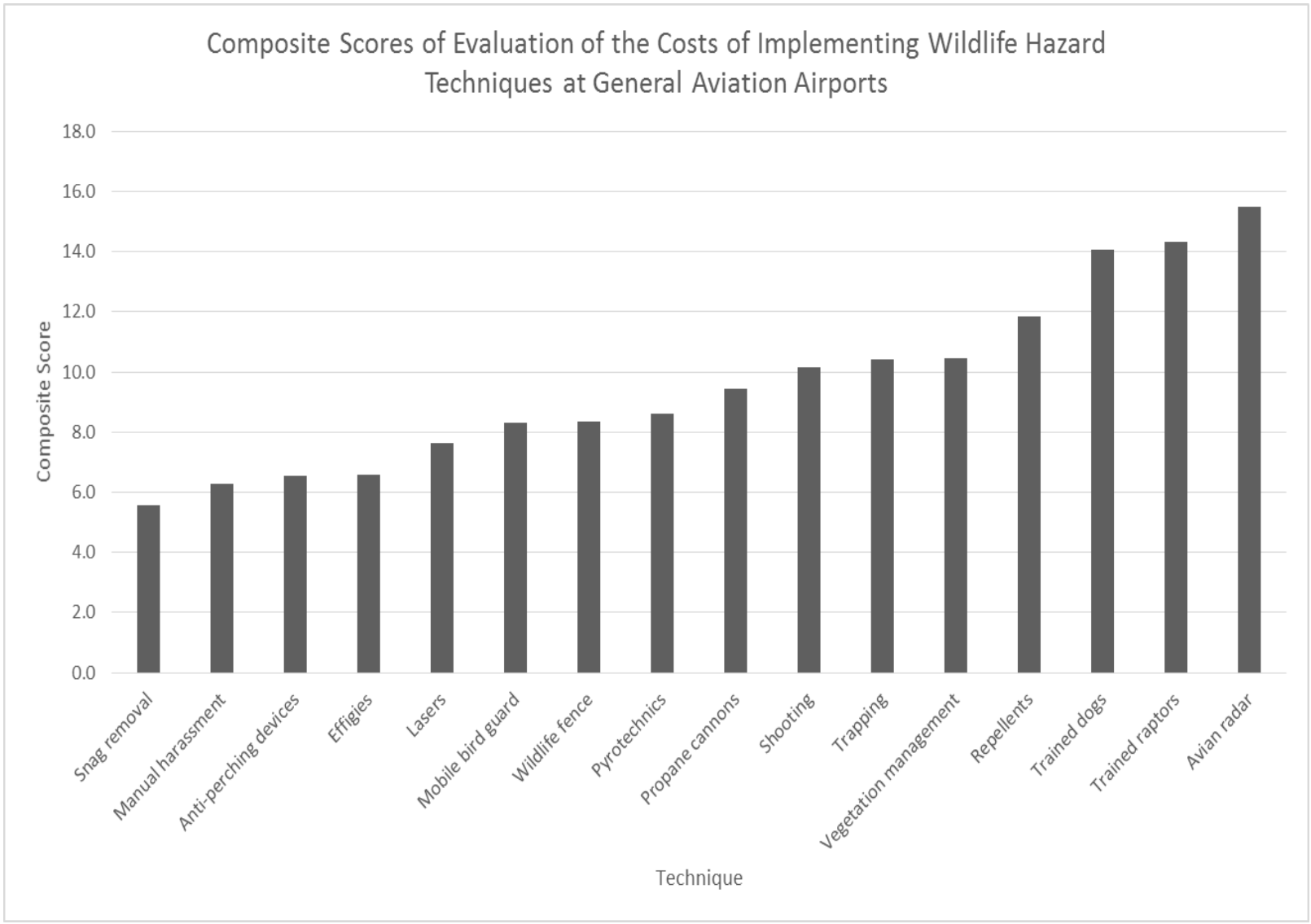

Table 1. Species and guilds identified as hazards to aviation during a February 2015 survey of wildlife hazard remarks at general aviation airports in the Aircraft Owners and Pilots Association Airports database. We surveyed 463/4,600 airports. Of the 463 airports surveyed, 157 had a wildlife hazard remark, with 30% describing more than one species or guild.

Type of Hazard	No. with Remark	% with Remark
Deer	81	51.6%
Birds	50	31.9%
General Remark	34	21.7%
Waterfowl	21	13.4%
Big Game	5	3.2%
Antelope	4	2.6%
Gulls	3	1.9%
Coyotes	3	1.9%
Swine	1	0.6%
Elk	1	0.6%

DISCUSSION

We found that 33.9% of GA airports had reported a wildlife hazard. This value only represents those airports that have recognized a hazard and have chosen to report it. Therefore, a lack of wildlife hazard remark does not necessarily mean that there is not a wildlife hazard present at that airport. Since there is no legal mandate to report wildlife hazards at GA airports, the true percentage of GA airports with wildlife hazards is certainly much higher.

Deer were the species most often identified as a wildlife hazard at airports. Deer are large, easily recognizable, and plentiful across the United States (Conover et al. 1995, McShea 2012). The frequency with which they are identified as a hazard could be due to limited funding at airports, resulting in no perimeter fence and easy access to the airfield for deer. It could also be due to the familiarity that the public has with deer-vehicle collisions. People understand, and often have witnessed, the damage that a deer-vehicle collision can have. Therefore, it is likely that they readily understand deer to be a catastrophic hazard to aircraft and readily remark even on limited numbers of deer as a wildlife hazard.

Birds were the second most often identified group of wildlife that were reported to pose a hazard at general aviation landing facilities. The generic use of the term "bird" masks the species and guilds that pose the largest hazards at general aviation facilities. This could be due to the large number of bird species that frequent airports, belonging to many different guilds, and a lack of skill or effort to identify birds that frequent each airport. A general wildlife hazard remark was the third most reported wildlife hazard remark. Similar to the "birds" remark, this generic term masks the species or guilds that pose the greatest hazards at general aviation facilities. This could also be due to a lack of skill in wildlife identification or a lack of effort to identify individual species or guilds.

We found much similarity among the responses of airport wildlife biologists regarding the costs associated with the implementation of various wildlife hazard management techniques. Responses for each technique generally had low variance (Fig. 1). This could be due to standardization of training.

The responses for shooting, pyrotechnics, and manual harassment were higher in the time per week and recurring costs categories than we had expected. This could be due to the fact that the respondents are full time airport wildlife biologists at large commercial and military airfields. In those situations, the amount of time and resources devoted to each technique may be much higher. For instance, a GA airport manager may only fire 50 pyrotechnics each month, yet a biologist at a large airfield may fire

50 pyrotechnics each day as a part of his daily duties, thereby increasing the time per week and recurring costs of this technique (Biondi et al. 2014).

Biologists reported that techniques such as anti-perch devices, snag removal, and manual harassment, had relatively low costs associated with their implementation. These techniques could likely be implemented on most GA airports without additional funding sources. Techniques such as pyrotechnics, shooting, lasers, and propane cannons had intermediate costs associated with their implementation. Some airports wishing to implement these techniques may need to seek external funding sources. Biologists reported that techniques such as repellents, trained animals, and radar had high costs associated with their implementation. These costs may be high enough that a GA airport wishing to implement these techniques must seek additional funding sources. These funding sources may include FAA Airport Improvement Program Grants, state Departments of Transportation, or local sources (Maryland Aviation Administration 2014). Though wildlife fences had high initial costs, their efficacy in excluding mammals from the airport environment as well as the measure of security they give to the airfield makes them a viable option for an airport that can secure external funding to construct it, but does not have large amounts of time to dedicate to it in the future. Avian radar was rated the most expensive technique overall. These costs, combined with the fact that avian radar does not directly mitigate wildlife hazards, reduces the utility of this technique on a GA airport.

We did not ask our survey respondents to evaluate the efficacy of various wildlife damage management techniques. While there is no ideal damage management technique, there are techniques that are more effective than others in a given situation. While this is a potential weakness of our survey, there are many documents that detail the efficacy of different management techniques (U.S. Air Force 2004, Cleary and Dolbeer 2005, ACRP 2010, Commander, Naval Installations Command 2010). Each airport must be individually evaluated for its specific hazard and mitigation techniques selected to reduce a particular hazard in particular environments.

MANAGEMENT IMPLICATIONS

We have shown that at least 33.9% of surveyed GA airports have reported a known wildlife hazard. Given that GA airports are under no legal obligation to report wildlife hazards, the actual percentage of GA airports with wildlife hazards is likely much higher. In addition, 51.6% of the surveyed airports reporting a hazard reported deer and 13.4% reported waterfowl. These specific guilds pose 2 of the greatest threats to aircraft, largely due to their body size (Wright et al. 1998, FAA 2014). Given that airport wildlife management training is readily available, as it is required for employees of those Part 139 airports that require a wildlife hazard assessment, managers of GA airports should receive training as well. This training will aid in the identification of hazardous species and also aid in the reporting of more wildlife strikes to aircraft. We suggest that GA airport managers and/or their employees contact nearby Part 139 airports to inquire about taking the Part 139 wildlife training.

This amount of risk serves to highlight the need for GA airports to consider the possibility of addressing wildlife hazards at their facilities. Lack of monetary resources often forces GA airports to reject the possibility of managing wildlife to reduce the risk to aviation (ACRP 2010). Our research has evaluated wildlife hazard mitigation techniques that are commonly implemented on Part 139 airports for the costs associated with their implementation. This should give airport managers who are wholly unfamiliar with wildlife management an idea of the relative amount of resources that will have to be devoted to each technique when the manager is considering the unique needs and fiscal situation of the airport. Knowing which techniques are fiscally feasible and which are not, will make the literature review for the implementation of wildlife hazard management techniques more efficient and productive for the airport manager. Before any wildlife hazard mitigation techniques are implemented, airport managers must positively identify the species or guilds that pose risks to aviation safety. If this is not done, airport managers may select

techniques that will not properly address the species or guilds causing risks.

Further research on this topic should include surveys among GA airport managers regarding knowledge of, and attitudes towards wildlife hazards and wildlife strike reporting. These surveys should include questions such as: do you consider a wildlife hazard to be present at your airport, if so, what species; has there ever been a wildlife strike at your airport, if yes, was it reported; do you know how to report wildlife strikes; do you actively manage wildlife at your airport; and are you aware of wildlife management resources available to you? Further research should also be conducted examining usage rates, among professional airport wildlife biologists, of the various wildlife mitigation techniques we listed.

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LITERATURE CITED

AIRCRAFT OWNERS AND PILOT'S ASSOCIATION (AOPA). About AOPA Airports. < http://www.aopa.org/airports/about/>. Accessed 2 Sept 2014.

AIRPORT COOPERATIVE RESEARCH PROGRAM. 2010. Bird harassment, repellent, and deterrent techniques for use on and near airports. Transportation Research Board. Washington D.C., USA.

BARTLETT, J. E., J. W. KOTRLIK, C. C. HIGGINS. 2001. Organizational research: determining appropriate sample size in survey research. Information Technology, Learning, and Performance Journal 19: 43-50.

BIONDI, K. M., J. L. BELANT, J. A. MARTIN, T. L. DEVAULT, AND G. WANT. 2014. Integrating mammalian hazards with management at U.S. civil airports: a case study. Human-Wildlife Interactions 8:31-38

BLACKWELL, B. F., L. SCHAFER, D. HELON, AND M. LINNELL. 2008. Bird use of stormwater-management ponds: decreasing avian attractants on airports. USDA National Wildlife Research Center-Staff Publications.

BLACKWELL, B. F., T. L. DEVAULT, E. FERNÁNDEZ-JURICIC, AND R. A. DOLBEER. 2009. Wildlife collisions with aircraft: a missing component of land-use planning for airports. USDA National Wildlife Research Center-Staff Publications 1-1-2009.

CLEARY, E. C. AND R. A. DOLBEER. 2005. Wildlife hazard management at airports: a manual for airport personnel. Second edition. Federal Aviation Administration and U.S. Department of Agriculture Animal & Plant Health Inspection Service. Washington D. C., Sandusky, Ohio USA.

COMMANDER, NAVAL INSTALLATIONS COMMAND, AIR OPERATIONS PROGRAM DIRECTOR. 2010. Bird/animal aircraft strike hazard (BASH) manual. Department of the Navy. Washington D.C., USA.

CONOVER, M. R., W. C. PITT, K. K. KESSLER, T. J. DEBOW, AND W. A. SANBORN. 1995. Review of human injuries, illnesses, and economic losses caused by wildlife in the United States. Wildlife Society Bulletin 23:407-414.

DEVAULT, T. L., B. F. BLACKWELL, AND J. L. BELANT, EDITORS. 2013. Wildlife in airport environments: preventing animal-aircraft collisions through science-based management. Johns Hopkins University Press, Baltimore, Maryland, USA.

FEDERAL AVIATION ADMINISTRATION. 2014. Wildlife strikes to civil aircraft in the United States: 1990-2013. National Wildlife Strike Database Serial Report Number 20. U.S. Department of Transportation. Washington D.C., USA.

FEDERAL AVIATION ADMINISTRATION. 2014. Airport Data and Contact Information. < http://www.faa.gov/airports/airport_safety/airportdata_5010/>. Accessed 2 Sept 2014.

FEDERAL AVIATION ADMINISTRATION. 2015. Recreational pilot and private pilot knowledge test guide. FAA-G-8082-17. U.S. Department of Transportation. Washington D.C., USA.

KELLERT, S. R., M. BLACK, C. R. RUSH, AND A. J. BATH. 1996. Human culture and large carnivore conservation in North America. Conservation Biology 10:977-990.

LEWIS, R. J. 2015. Opportunity to participate in wildlife hazard at airports survey. Interactions 21(1):4.

MARYLAND AVIATION ADMINISTRATION. 2014. State grant funding for special projects, guide for grant sponsors. Maryland Aviation Administration, BWI Airport, Maryland, USA.

MCSHEA, W. J. 2012. Ecology and management of white-tailed deer in a changing world. Annals of the New York Academy of Sciences 1249:45-56.

U.S. AIR FORCE. 2004. Air Force pamphlet 91-212: Bird/wildlife aircraft strike hazard (BASH) management techniques. Washington D.C., USA.

U.S. DEPARTMENT OF AGRICULTURE ANIMAL & PLANT HEALTH INSPECTION SERVICE WILDLIFE SERVICES. 2005. Managing Wildlife Hazards at Airports. Revised edition.

WEAVER, G. R. 1999. American cultural values. Kokusai Bunka Kenshu (Intercultural Training). 14:14-25.

WRIGHT, S. E., R. A. DOLBEER, AND A. J. MONTONEY. 1998. Deer on airports: an accident waiting to happen. Proceedings of the Eighteenth Vertebrate Pest Control Conference 18:90-95.

YORK, D. L, J. L. CUMMINGS, R. M., ENGEMAN, AND K. L. WEDEMEYER. 2000. Hazing and movements of Canada geese near Elmendorf Air Force Base in Anchorage, Alaska. USDA National Wildlife Research Center- Staff Publications 1-1-200.