

ACRP

SYNTHESIS 39

**AIRPORT
COOPERATIVE
RESEARCH
PROGRAM**

Airport Wildlife Population Management

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A Synthesis of Airport Practice

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ACRP SYNTHESIS 39

Airport Wildlife Population Management

A Synthesis of Airport Practice

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Airports are vital national resources. They serve a key role in transportation of people and goods and in regional, national, and international commerce. They are where the nation's aviation system connects with other modes of transportation and where federal responsibility for managing and regulating air traffic operations intersects with the role of state and local governments that own and operate most airports. Research is necessary to solve common operating problems, to adapt appropriate new technologies from other industries, and to introduce innovations into the airport industry. The Airport Cooperative Research Program (ACRP) serves as one of the principal means by which the airport industry can develop innovative near-term solutions to meet demands placed on it.

The need for ACRP was identified in *TRB Special Report 272: Airport Research Needs: Cooperative Solutions* in 2003, based on a study sponsored by the Federal Aviation Administration (FAA). The ACRP carries out applied research on problems that are shared by airport operating agencies and are not being adequately addressed by existing federal research programs. It is modeled after the successful National Cooperative Highway Research Program and Transit Cooperative Research Program. The ACRP undertakes research and other technical activities in a variety of airport subject areas, including design, construction, maintenance, operations, safety, security, policy, planning, human resources, and administration. The ACRP provides a forum where airport operators can cooperatively address common operational problems.

The ACRP was authorized in December 2003 as part of the Vision 100-Century of Aviation Reauthorization Act. The primary participants in the ACRP are (1) an independent governing board, the ACRP Oversight Committee (AOC), appointed by the Secretary of the U.S. Department of Transportation with representation from airport operating agencies, other stakeholders, and relevant industry organizations such as the Airports Council International-North America (ACI-NA), the American Association of Airport Executives (AAAE), the National Association of State Aviation Officials (NASAO), Airlines for America (A4A), and the Airport Consultants Council (ACC) as vital links to the airport community; (2) the TRB as program manager and secretariat for the governing board; and (3) the FAA as program sponsor. In October 2005, the FAA executed a contract with the National Academies formally initiating the program.

The ACRP benefits from the cooperation and participation of airport professionals, air carriers, shippers, state and local government officials, equipment and service suppliers, other airport users, and research organizations. Each of these participants has different interests and responsibilities, and each is an integral part of this cooperative research effort.

Research problem statements for the ACRP are solicited periodically but may be submitted to the TRB by anyone at any time. It is the responsibility of the AOC to formulate the research program by identifying the highest priority projects and defining funding levels and expected products.

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Primary emphasis is placed on disseminating ACRP results to the intended end-users of the research: airport operating agencies, service providers, and suppliers. The ACRP produces a series of research reports for use by airport operators, local agencies, the FAA, and other interested parties, and industry associations may arrange for workshops, training aids, field visits, and other activities to ensure that results are implemented by airport-industry practitioners.

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Cover figure: Canada Geese at Illinois general aviation airport (Source: BASH Inc.).

FOREWORD

Airport administrators, engineers, and researchers often face problems for which information already exists, either in documented form or as undocumented experience and practice. This information may be fragmented, scattered, and unevaluated. As a consequence, full knowledge of what has been learned about a problem may not be brought to bear on its solution. Costly research findings may go unused, valuable experience may be overlooked, and due consideration may not be given to recommended practices for solving or alleviating the problem.

There is information on nearly every subject of concern to the airport industry. Much of it derives from research or from the work of practitioners faced with problems in their day-to-day work. To provide a systematic means for assembling and evaluating such useful information and to make it available to the entire airport community, the Airport Cooperative Research Program authorized the Transportation Research Board to undertake a continuing project. This project, ACRP Project 11-03, "Synthesis of Information Related to Airport Practices," searches out and synthesizes useful knowledge from all available sources and prepares concise, documented reports on specific topics. Reports from this endeavor constitute an ACRP report series, *Synthesis of Airport Practice*.

This synthesis series reports on current knowledge and practice, in a compact format, without the detailed directions usually found in handbooks or design manuals. Each report in the series provides a compendium of the best knowledge available on those measures found to be the most successful in resolving specific problems.

PREFACE

By Gail R. Staba
Senior Program Officer
Transportation Research Board

This synthesis provides direct wildlife population control techniques for reducing wildlife collisions with aircraft. This report synthesizes the various direct wildlife population control techniques available to airport personnel and their relative effectiveness. In addition, the ecological foundation of wildlife population control and management is also summarized.

A literature review and survey of individuals involved in wildlife management at airports was conducted. The 15 airports surveyed (100% response rate) were representative of a broad range of biological habitats and conditions across the United States from all nine FAA regions. These airports were surveyed to obtain quantitative and qualitative information on existing wildlife population control methods and integrated management approaches currently used in the United States and their perceived effectiveness.

Russell P. DeFusco and Edward T. Unangst, BASH Incorporated, Colorado Springs, Colorado, collected and synthesized the information and wrote the report. The members of the topic panel are acknowledged on the preceding page. This synthesis is an immediately useful document that records the practices that were acceptable within the limitations of the knowledge available at the time of its preparation. As progress in research and practice continues, new knowledge will be added to that now at hand.

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Note: Many of the photographs, figures, and tables in this report have been converted from color to grayscale for printing. The electronic version of the report (posted on the Web at www.trb.org) retains the color versions.

AIRPORT WILDLIFE POPULATION MANAGEMENT

SUMMARY Wildlife and aviation can be a dangerous combination. Airport managers and other transportation safety and security officials have spent significant financial and personnel resources in an effort to prevent or mitigate the possibility of aircraft collisions with wildlife. In the past two decades, wildlife strikes have increased fivefold, from 1,770 reported in 1990 to 10,083 reported in 2011. The rise in strikes results in part from increases in bird populations, with 13 of the 14 largest bird species showing significant population increases over this period. Since 1988, wildlife strikes to civil aircraft have resulted in at least 24 deaths and 235 injuries in the United States, and 250 deaths and the destruction of more than 220 aircraft globally. They also have led to annual direct economic losses to civil aircraft that were conservatively estimated by Allan in 2002 to exceed \$1.2 billion worldwide and have caused nearly 600,000 hours of aircraft downtime. In the United States alone, damage costs exceed \$625 million annually (*Wildlife Strikes to Civil Aircraft in the United States, 1990–2010*). Factors that contribute to this increasing threat are expanding populations of large birds and increasing air traffic by quieter, turbofan-powered aircraft (*Wildlife Strikes to Civil Aircraft in the United States, 1990–2011*). Following the highly publicized bird strike that forced US Airways Flight 1549 to make an emergency landing in the Hudson River in January 2009, public awareness of wildlife collisions with aircraft is at an all-time high. In response, more airports primarily attempt to manage and control wildlife risk using techniques such as habitat manipulation, harassment, deterrence, and exclusion, with varying degrees of effectiveness. However, as part of an integrated wildlife population management program, more direct wildlife population control methods such as lethal and nonlethal trapping; the use of pesticides and chemicals; roost site, nest, and egg destruction; and even live-ammunition shooting may be necessary. Currently, research-backed information on these approaches to wildlife population management at airports is often scattered throughout numerous different disciplines and research fields, with few efforts made to develop a comprehensive synthesis of population management techniques.

ACRP Synthesis 23: Bird Harassment, Repellent, and Deterrent Techniques for Use on and Near Airports provided a synthesis of nonlethal wildlife control measures focusing on birds. The objective of this current synthesis is to provide airport managers, operators, and biologists with a document that supplements *ACRP Synthesis 23* through a review of more direct wildlife population control techniques for reducing wildlife collisions with aircraft. The combined information from the two syntheses will provide a foundation for airports in their development of an effective integrated wildlife population control strategy and program. To gather relevant information on current practices, primary and secondary literature was reviewed using multiple data sources. In addition, 15 airports (100% response rate) covering a broad range of biological habitats and conditions across the United States from all nine FAA regions were surveyed to obtain quantitative and qualitative information on existing wildlife population control methods and integrated management approaches currently used and their perceived effectiveness. Using information from the literature, combined with the survey results, the various direct wildlife population control techniques and their relative effectiveness were synthesized. The ecological foundation of wildlife population control and management is also summarized. As expected, wildlife population control techniques can vary markedly at both the avian and mammalian species levels, as well as at avian and

mammalian guild levels. Appropriate wildlife population control measures are dependent on factors such as habitat, wildlife abundance and distribution, density, seasonality, fidelity, and physiological characteristics. Successful integrated approaches to wildlife population control and management consistently include appropriate use of habitat management, harassment, repellent, and exclusion techniques (*ACRP Synthesis 23*) supplemented with more direct wildlife population control measures, to include lethal control, as necessary (this synthesis). Overall, the integration of both approaches to wildlife population control is often more effective than reliance on a single approach.

Because many of these wildlife population control measures and population management approaches do not have sufficient empirical evidence to support or refute the long-term effectiveness of the techniques being employed under different circumstances, continued assessment of these techniques is necessary. This may be accomplished initially through quantification of techniques currently used at airports, combined with more directed scientific studies. Additionally, reviews of other aspects of wildlife population control and integrated management techniques at airports focusing on habitat modification and effects on population control are warranted. This synthesis may provide impetus to undertake research that could lead to more refined approaches for the further evaluation of wildlife population control effectiveness on airports, the potential effect on metapopulations outside the airport boundaries, and broader recommendations to advance the science of aviation wildlife hazard mitigation.

INTRODUCTION

BACKGROUND

This synthesis provides airport managers and biologists with a working reference document that reviews the tools, methods, techniques, procedures, and considerations for reducing aircraft collisions associated with wildlife population control management on airports and in the immediate surrounding areas. Wildlife population control on airports is a unique application of more broadly defined wildlife damage management that can and should be used as part of an integrated wildlife management strategy. Historically, wildlife damage management has focused on overabundant species and their effects on property, especially agriculture (Curtis et al. 1996; Conover 2002; Decker et al. 2002; Cleary and Dolbeer 2005). However, wildlife population management on airports often deals with wildlife that may not be overabundant yet pose significant risks to human safety and health and potentially damage aircraft and facilities (see Figure 1). Thus, when effective use of wildlife population control measures on airports is used, a reduction in wildlife collisions with aircraft and aviation risk to human safety is possible.

Wildlife population management on airports has been reported in many formats. Worth noting are the following foundational reference sources pertinent to wildlife management on airports by Blokpoel (1976), DeFusco and Nagy (1983), Hygnstrom et al. (1994), Harris and Davis (1998), MacKinnon et al. (2001), Transport Canada (2002), Cleary and Dolbeer (2005), Cleary and Dickey (2010), and Belant and Martin (2011). Because airport personnel are legally and professionally obligated to reduce wildlife risks to aviation, these sources provide both diverse and specific information useful to airport personnel relative to wildlife hazards.

For the purposes of this synthesis, we have classified the two wildlife population management approaches as either indirect (e.g., habitat modification, harassment, deterrents, repellents, and exclosures) or direct (e.g., lethal and nonlethal trapping; roost, nest, and egg manipulation; chemical and pesticide application; and live-ammunition shooting). Integrated airport wildlife population management as a matter of common practice may, and in most cases should, involve a combination of both indirect nonlethal measures and more direct, sometimes lethal, wildlife population control techniques. Indirect nonlethal wildlife management methods for birds are specifically addressed in *ACRP Synthesis 23* (Belant and Martin 2011) and a review of both methods pertinent to general avi-

ation (GA) airports in *ACRP Report 32* (Cleary and Dickey 2010). Although indirect methods are more commonly used and are the industry standard for nonlethal wildlife management on airports, animals may adapt and change behaviors in response to such techniques and may require additional nonlethal and/or direct lethal measures to improve wildlife control effectiveness.

Many airports are reluctant to use more direct and often lethal modes of wildlife population control for many reasons including a lack of knowledge of the various direct wildlife population control techniques and methods available; a misunderstanding of such actions on overall wildlife populations outside airport boundaries (metapopulations); a lack of knowledge of permit and license requirements necessary to conduct direct wildlife population control; and fear of public outcry and a lack of public support because of such actions. An integrated approach requires the use of all elements to be most successful. Generally, wildlife management and population control efforts take a hierarchical approach, with the basis of the program resting on habitat management supplemented by various exclusion and deterrent methods (see Figure 2). Direct removal of animals and especially lethal methods are only effective in the long run when the foundational bases of population management are in place and are most often used as a last resort to reinforce other methods. Nevertheless, a more direct wildlife population control approach can be used on airports that result in the removal, relocation, or lethal reduction of problematic wildlife individuals or populations. It is important that airport managers, operations staff, and their contracted support personnel be equipped with the most current information on the use of direct wildlife population control methods and their effectiveness. To improve effectiveness, the selection and application of such methods must be consistent with targeted wildlife (vertebrate and invertebrate) ecology.

WILDLIFE AND AIRCRAFT

Conflicts arising from the presence of wildlife and aviation operations remain problematic. Wildlife biologists and aviation personnel have been aware of aircraft collisions with birds and other wildlife (wildlife strikes) for decades (Solman 1973; Blokpoel 1976). In 2009, the forced landing of US Airways Flight 1549 in the Hudson River renewed public interest in risks to aircraft posed by wildlife (Marra et al. 2009). The



FIGURE 1 Canada Goose and American Elk strikes to aircraft (Source: USDA).

following information highlights the real and potential wildlife threat to aviation. Note that the following data are those actually reported and are generally accepted to underrepresent actual losses by between 61% and 89% (Linnell et al. 1999; Cleary et al. 2005; Wright and Dolbeer 2005). Projected total costs are significantly higher than those that are reported in the FAA National Wildlife Strike Database and are estimated at \$15.787 billion over the period from 1990 to 2011 (Dolbeer et al. 2012):

1. Since the inception of the FAA National Wildlife Strike Database in 1990, 119,917 reported wildlife strikes had projected annual average costs of \$718 million in the United States (Dolbeer et al. 2012). In addition, strikes to civil aircraft worldwide have resulted in at least \$1.2 billion in losses annually (damage to aircraft and

associated costs) and more than 250 human lives lost (Allan 2002).

2. The number of wildlife strikes reported annually has increased more than fivefold, from 1,804 in 1990 to 10,083 in 2011 (Dolbeer et al. 2012).
3. In 2011, 27.6 wildlife strikes per day were reported in the United States (Dolbeer et al. 2012). U.S. airports reporting wildlife strikes increased from 333 in 1990 to a high of 597 (369 airports certificated for passenger service and 228 GA airports) in 2011 (Dolbeer et al. 2012).
4. Of all aircraft wildlife strikes in the United States, 97.1% involve birds, with terrestrial mammals involved in 2.3%, bats 0.5% (Peurach et al. 2009), and reptiles 0.1% (Dolbeer et al. 2012).
5. From 1990 to 2011, 462 bird species and 38 species of terrestrial mammals were struck by aircraft (Dolbeer et al. 2012) with waterfowl, gulls, and raptors being the species groups with the greatest number of damaging strikes (see Figure 3). Deer (39%) (DeVault et al. 2008; VerCauteren et al. 2009, 2011) and coyotes (34%) are the most frequently struck terrestrial mammals, with deer responsible for 93% of all damaging mammal strikes (Dolbeer et al. 2012).
6. Gulls (16%), doves and pigeons (15%), raptors (13%), and waterfowl (7%) were the most frequently struck bird groups (Dolbeer et al. 2012).
7. From 1990 to 2011, Canada Geese were reportedly involved in 1,351 civil aircraft strikes, resulting in 2 fatalities, 19 injuries, and 5 total aircraft lost. Reported Canada Geese strikes caused a minimum of \$2.6 million in damage each year, with total reported losses exceeding \$90 million (Dolbeer and Wright 2008; Dove et al. 2009; Dolbeer et al. 2012). Projected costs



FIGURE 2 Hierarchy of airport wildlife population control in an integrated program (Source: MSP).



FIGURE 3 Eagle strike at Minneapolis–St. Paul International Airport (MSP) (Source: MSP).



FIGURE 4 Canada Goose strike on GA aircraft (Source: Transport Canada).

accounting for underreporting rates may conservatively total as much \$2.97 billion based on estimates in Dolbeer et al. (2012). In addition, Canada Geese were responsible for the loss of a USAF AWACS aircraft in 1995 that killed 24 aircrew and cost in excess of \$280 million (Gresh 1996).

8. From 1990 to 2011, 897 U.S. civil aircraft incidents with white-tailed deer were reported resulting in 1 of 24 human deaths and 25 of 256 injuries reported for all wildlife incidents during this period. Although deer incidents for all species represent only 0.9% of all wildlife strikes reported, they account for 5.4% of estimated costs, resulting in a minimum of \$75 million in total reported damages and as much as \$852 million in projected damages (Biondi et al. 2011; Dolbeer et al. 2012).

Aircraft movements have increased approximately 3% per year (17.8 million aircraft movements in 1980 to 25.2 million in 2011) with passenger enplanements in the United States increasing from 310 million in 1980 to 715 million in 2011. In addition, the numbers of wildlife species have increased over the same period, including many species that pose the greatest risk to aviation (Dolbeer et al. 2000). As a result, the skies are becoming increasingly crowded, with aircraft and hazardous bird species occupying the same space (Dolbeer 2009). In addition, highly successful programs funded by the U.S. government during the past 40 years (e.g., pesticide regulation, expansion of the wildlife refuge systems, and wetlands restoration), coupled with land-use changes, have brought about dramatic increases in the populations of many larger-bodied bird species in North America (Dolbeer et al. 2000; Dolbeer and Eschenfelder 2003) as highlighted here:

1. Large bird species increased significantly from 1980 to 2011, including Bald Eagles, Wild Turkeys, Canada Geese (see Figure 4), American White Pelicans, Double-

crested Cormorants, Sandhill Cranes, Osprey, and Red-tailed Hawks (Dolbeer et al. 2012).

2. In the past 40 years, 13 of the 14 largest-bodied bird species in the United States (>3.6 kg body mass) have shown significant population increases (Dolbeer and Eschenfelder 2003).
3. In North America from 1970 to 2008, migratory and nonmigratory populations of Canada Geese (4.2 kg body mass) have more than quadrupled from 1.2 million to 5.5 million birds. Resident (nonmigratory) Canada Geese populations appear to have stabilized at approximately 3.5 million birds during the last decade (Dolbeer 2011).
4. Many birds have adapted to urban environments and have found that airports, with their large areas of grass and pavement, are attractive habitats for feeding and resting. Other wildlife such as deer and coyotes are also attracted to airport environments for similar reasons.
5. White-tailed Deer populations (see Figure 5) increased from about 350,000 in 1984 to more than 28 million in 2010 (McCabe and McCabe 1997; VerCauteren et al. 2006, 2011).
6. Further exacerbating the problem, today's modern jet turbofan-powered aircraft are much faster and relatively quiet compared with their piston-powered predecessors, resulting in dramatic changes in the dynamics of bird and aircraft interactions (Burger 1983; Kelly et al. 2000). In 1965, 90% of the 2,100 U.S. passenger aircraft had three or four engines. By 2005, the U.S. passenger fleet had grown to 8,200 aircraft, with only 10% having three or more engines.

Wildlife strikes most commonly occur on or in close proximity to airports.

1. From 1990 to 2011, 72% and 75% of bird strikes for commercial and GA aircraft, respectively, occurred



FIGURE 5 (left) White-tailed Deer strike with Piedmont Dash 8 at Charlotte–Douglas International Airport (CTL); note aircraft maximum braking tire tracks (Source: CTL); (right) Cessna Citation 550 destroyed by White-tailed Deer strike at Greenwood County Airport (GRD), South Carolina (Source: FAA).

below 3,500 ft above ground level (AGL) (Dolbeer 2006; Dolbeer et al. 2012); effectively within 10,000 ft from the airfield based on a 3° glideslope (Blackwell et al. 2009). At that altitude, aircraft would be within about 5 miles from the airfields of the busiest airports (Federal Aviation Administration 2007).

2. Above 500 ft AGL, the number of strikes declined by 33% for each 1,000-ft gain in altitude for commercial aircraft and by 41% for GA aircraft. Strikes above 500 ft were more likely to cause damage than strikes at or below 500 ft (Dolbeer et al. 2012).
3. Dolbeer (2011) reported that bird strike rates above 500 ft AGL have increased since 1990, whereas strike rates below 500 ft AGL have decreased during that period.
4. After striking wildlife, a precautionary or emergency landing was the most commonly reported negative effect on a flight (4,353 incidents), including 46 incidents where pilots dumped fuel to lighten aircraft weight and 76 incidents where an overweight (heavy) landing was made. An aborted takeoff was the second most common negative effect (1,922 incidents), which included 805 aborted takeoffs at greater than 80 knots (Dolbeer et al. 2012).
5. Fifty-seven wildlife strikes resulted in destroyed aircraft, with 56% of these occurring at GA airports (see Figure 6) (Dolbeer et al. 2012).

From 1990 to 2011, empirical data suggest that recent wildlife management on airports may have contributed to a reduction in wildlife strike rates and damaging wildlife strikes on airports (Dolbeer et al. 2012). Since 1990, wildlife management actions to mitigate wildlife risk have been implemented at many airports and these actions are likely responsible for the general decline in reported wildlife strikes with damage on airports from 2000 to 2011. Damages to aircraft and accidents remain a problem in the off-airfield environment and it is evident that more needs to be done to address those problems. Future management actions at airports should be prioritized

based on the hazard level of species observed in the aircraft operating area (Dolbeer et al. 2012) and in surrounding airspace. Because airport sponsors and managers are legally obligated under 14 CFR Part 139 to make certain that the airport environment and areas near the airport are safe, continued and improved integrated wildlife population management remains a necessity (see Figure 7).

In *ACRP Report 32*, Cleary and Dickey (2010) suggested that airport managers can use five basic strategies to manage hazardous wildlife at or near the airport:

1. Habitat modification: Elimination or reduction of food, water, or shelter attractive to wildlife at or near the airport.
2. Exclusion: Use of physical barriers to stop wildlife from gaining access to food, water, or shelter at or near the airport.



FIGURE 6 Canada Geese at Illinois GA airport (Source: BASH Inc.).



FIGURE 7 Sandhill Cranes pose potential risk at Orlando International Airport (MCO) (Source: MCO).

3. Repellent techniques: Use of various audio, visual, or chemical repellents to harass and repel problem wildlife.
4. Population management: Reduction or elimination of wildlife populations posing a hazard to aircraft at or near the airport by either capturing (live capture and relocation) or killing the problem animals.
5. Notices to Airmen (NOTAM) of potential wildlife hazards.

This synthesis primarily emphasizes strategy 4—population management; however, the use of indirect habitat modification, deterrent, repellent, and exclusion techniques cannot be considered in isolation and typically are applied in conjunction with an integrated wildlife population management strategy.

SYNTHESIS METHODOLOGY

Literature Search

A review of the literature was conducted for papers that included information regarding wildlife population control methods. Most of the literature review focused on studies conducted within the airport environment because they provide more relevant information about methods, techniques, and effectiveness needed by airport personnel, although the overall scientific basis for these studies is well supported in other literature. Numerous databases were used to find primary and secondary literature including Google Scholar; DigitalCommons at the University of Nebraska, Lincoln; JSTOR™; Web of Science™; as well as numerous conference proceedings databases (e.g., ecological societies, Vertebrate Pest Conferences, and Bird Strike Committee's proceedings). The following terms and keywords were searched for in article abstracts: bird strike, damage management, airports, aviation, wildlife control, population control, and population management, alone or in combinations. These searches were supplemented by examining bibliographies of articles for additional references.

Survey

Fifteen representative airports from all nine FAA regions were sent a wildlife populations control and management survey (Appendix D). All responded; a 100% survey response rate. The qualitative and quantitative information from the returned surveys were then compiled to discuss the various lethal and nonlethal wildlife population control techniques currently practiced by U.S. airports and their perceived effectiveness (as reported in chapter six).

CHAPTER OUTLINES

Chapter two provides a general discussion of wildlife population management from an historical, biological, and ecological framework. In addition, federal and state agencies with wildlife oversight responsibilities, legal requirements and responsibilities, and the requirement for depredation permits are addressed. A general overview of specific direct wildlife population control methods and techniques is also covered. Chapter three addresses specific wildlife population control alternatives. Chapter four addresses federal and state threatened and endangered species and game species issues. Chapter five discusses wildlife population control issues directed at specific “high risk” bird and mammal species and more general wildlife control techniques targeted at avian and mammalian guilds where species-specific discussion was less appropriate. Chapter six provides the results of airport-provided survey information and “lessons learned” relative to specific and general wildlife control measures and their overall effectiveness. This information is intended to provide an experienced perspective that includes suggestions to airports when developing, planning, and implementing an integrated wildlife population control strategy and program. Chapter seven summarizes the successful practices and provides recommendations for further research in the area of airport wildlife population management.

AIRPORT WILDLIFE POPULATION MANAGEMENT

WILDLIFE POPULATION MANAGEMENT: AN OVERVIEW

Wildlife is a public resource. Until the 1970s, wildlife management was primarily a form of game management that focused on the husbandry and regulation of bird and mammal populations for sport and was synonymous with animals that were hunted. In 1973, the U.S. Congress defined wildlife as the following: “the term fish or wildlife means any member of the animal kingdom, including without limitation any mammal, fish, bird (including any migratory, nonmigratory, or endangered bird for which protection is afforded by treaty or international agreement), amphibian, reptile, mollusk, crustacean, arthropod, or other invertebrate, and includes any part, product, egg, or offspring thereof, or dead body parts or parts thereof.” The Wildlife Society defines wildlife as “free-living animals of major significance to man.” Currently, most free-living animals are significant to humans, resulting in an expansion of its meaning, but often remain historically restricted to terrestrial and aquatic vertebrates.

Wildlife management implies stewardship. As previously noted, airport sponsors, managers, and operators are legally obligated to manage wildlife to improve safety. For example, efforts to improve aircraft safety through wildlife management can be approached with the same degree of concern as with foreign object damage; both can have catastrophic consequences. Simplistically, wildlife management can be active, where measures are implemented to change existing situations, or inactive, often described as passive or nonmanagement where no action is taken. Nevertheless, the goal of wildlife management has one of four options (Caughley 1994):

1. Make a population increase.
2. Make a population decrease.
3. Harvest a population for a continued yield.
4. Do nothing except monitor the population.

All options are possible in airport wildlife population management, dependent on the goals expected. In developing a wildlife population management strategy, three decisions are needed (Sinclair et al. 2006):

1. What is the desired goal?
2. Which management option is therefore appropriate?
3. By what action is the management option best achieved?

Once the goals are established, airport managers can then determine the appropriate wildlife population management action (Decker et al. 2002). The establishment of the goals is a value judgment; however, how the goals are achieved involves technical evaluation, decisions, and application.

Ecologically, a population can be defined as a group of organisms of the same species that occupies a given area over a specified time period. Species of a given population select habitats to occupy that meet their needs for food, water, and cover, often combined and referred to as habitat and depicted as a “habitat triangle” in ecological literature (see Figure 8). Food and water are necessary in acceptable amounts for a population to remain within a given space at a given time. Cover is shelter for wildlife and consists of vegetation and topographic features that provide places to feed, hide, sleep, play, and raise young (Leopold 1933). Wildlife uses cover for various reasons such as seasonal, refuge, resting, nesting, roosting, thermal, escape, bedding, and other types that are important in the varied life histories of different species (Krausman 2002). Thus, habitat refers to the resources and conditions present in an area that produce occupancy by a given individual and population to sustain survival and reproduction.

Organisms live within a range of resource tolerances, or ecological amplitude, for each of the physical and biological components of their environment. Whenever the upper or lower optimal limit of the range is exceeded, organisms experience difficulties and may not survive at a particular location. Therefore, plants and animals survive only so long as they can compete successfully for resources. In general, each species is the product of a long evolutionary history that is governed largely by competition (Krausman 2002; Bolen and Robinson 2003; Sinclair et al. 2006). This evolutionary history results in a species’ steady improvement in the way they “fit” into their environment. For some species, the fit is tight, with no room for dealing with change. Such species are referred to as “specialists.” Most federal- or state-listed threatened and endangered species and those tied to specific habitat types are specialists, with some posing direct or indirect hazards to aviation. Examples include Whooping Cranes, Upland Sandpipers, Grasshopper Sparrows, and Burrowing Owls. In contrast, other species are highly adaptable and can deal with a wide range of environmental conditions; these are called “generalists.” Generalists include such species as



FIGURE 8 Habitat triangle
(Source: BASH Inc.).

gulls, pigeons, corvids, starlings, coyotes, deer, commensal rodents, and others that are often the most significant hazardous species on airports. In both cases, the species possess a unique ability to live within its own zone of tolerance and perform a unique role within the habitat. This role or function is known as its ecological niche. By understanding an organism's niche, airport operators can select the most appropriate wildlife management approach. Unfortunately, this variable nature of niche for each species results in no "cookie-cutter," "silver bullet," or "one size fits all" approach to effective wildlife management.

WILDLIFE POPULATION MANAGEMENT: AIRPORT WILDLIFE CONTROL

For airports, wildlife control involves three general strategies (see Figure 9). The first two strategies deal with the direct manipulation of animal numbers; the third adjusts for future action based on the analysis of past control method effectiveness. These include:

1. A management action designed to restore an errant system to its previous stable state by reducing animal numbers.
2. Moving a system away from its stable state to another that is more desirable. In such cases, animal density is



FIGURE 9 Cattle Egrets foraging near airport taxiway at MCO
(Source: MCO).

reduced and the new density enforced by continuous control operations.

3. The third wildlife population control strategy deals with adaptive management to evaluate effectiveness and continually adjust wildlife control methods.

To achieve airport wildlife population control strategy objectives, specific methods can be divided into those aimed at:

1. Directly increasing mortality.
2. Directly reducing reproduction.
3. Indirectly manipulating mortality, reproduction, or both.

Thus, integrated airport wildlife management consists of both direct action (the focus of this synthesis) and indirect action (habitat modification, harassment, deterrence, exclusion) of wildlife population control on airports. It is important to note that the success of an airport wildlife population control operation is not gauged merely by the reduction in population numbers or density of the targeted animals but rather by the reduction in the potential wildlife hazards to aviation operations and safety. In all cases, the prime responsibility of the airport operators and wildlife managers is to determine whether the wildlife population control measure adequately produces the desired effects. Such risk analysis is an essential part of continuous monitoring, record keeping, and adaptive management efforts to determine effectiveness of the wildlife management program consistent with Safety Management System principles.

There are three circumstances where wildlife control measures may not be an appropriate management action (Sinclair et al. 2006):

1. Where the costs exceed the benefits.
2. When the "targeted animal" is not the cause of the problem.
3. Where the control has an unacceptable effect on non-target animals.

As previously discussed, habitat dictates wildlife occupancy; therefore, effective wildlife control follows the identification of habitat diversity on and near the airport. In general, increased habitat diversity results in a greater number of species occupying a given area at a given time. If an airport has high habitat diversity (grasslands, woodlands, aquatic features, etc.), then there is a resulting increase in the available ecological niches that the airport habitats can support. In most cases, wildlife will fill those available niches at population levels that the habitat resources can support, often referred to as carrying capacity. In contrast, if an airport has low habitat diversity and is fairly homogeneous, then there is a resulting decrease in ecological niche diversity. Because the niche diversity is fairly similar in homogeneous habitat, most likely fewer species will occupy this habitat and the

area may have a lower overall carrying capacity and resultant risk to aviation operations. In general, given airports of similar size, a more homogeneous habitat will have fewer overall species but potentially a greater number of individuals of these species occupying the given area at a given time. A more diverse habitat may have a greater number of species but with fewer numbers of individuals of certain species. Because habitat and ecological niche diversity determines what species occupy a given area at a given time, it is equally important to understand what species are present and in what numbers they are present on an airport. Unfortunately, wildlife may utilize the airport habitat differentially; occupants may be resident or transient. This is particularly true with birds that have both migratory and nonmigratory populations. Wildlife activity can also vary on a daily and seasonal basis consistent with its life history characteristics.

It can be seen that evaluating potential wildlife problems on and near airports can be extremely variable and potentially confusing. The following checklist provides guidance in solving any airport wildlife population problem by answering the following nine questions for each problem species (Cleary and Dolbeer 2005):

1. What is the wildlife doing that make the control of their numbers or damage necessary? The type of activity that needs to be controlled will determine both the severity of the problem and the type of control methods used.
2. Which species of wildlife are causing the problem? Accurate identification of the exact species is critical because different species often require different management techniques.
3. Why is the wildlife on the airport? Are they attracted to the airport for food, water, or shelter, or are they just flying over the airport from nighttime roosting sites to daytime feeding sites? The answer to this question will determine, to a large extent, the most appropriate control methods to use.
4. What are the daily and seasonal movement patterns of the wildlife among feeding, loafing, and roosting/ nesting areas? It is important to identify the times of day and seasons of the year, as well as locations on the airport where the wildlife pose the most critical threat to aviation safety and where they are most vulnerable to management actions.
5. What is the legal status at the federal, state, and local levels of the problem species? All wildlife species are not afforded equal legal protection by all levels of government.
6. What effective and legal management methods are available? In wildlife hazard management effective and legal are not necessarily synonymous.
7. How selective are these control methods? The objective is to control only the target wildlife, not every species in the area.
8. How much will it cost to apply the selected control methods? The cost of control might dictate which methods are practical, given the seriousness of the threat caused by the species.
9. What are public attitudes toward the problem wildlife species and the hazards that these species pose?

“Vegetation Rehabilitation and Direct Wildlife Control”
Charlotte Douglas International Airport (CTL)

Our airport performed a runway rehabilitation project where the runway safety areas were seeded with grass seed to prevent erosion.

Unfortunately, these conditions attracted various species, most notably Mourning Doves and Rock Pigeons, leading to significant increases in bird strikes. Thus, we started aggressive direct wildlife control measures to reduce these populations leading to immediate drastic reductions in bird strikes by these species.



Runway construction and Rock Pigeons feeding on newly seeded grass at CTL (Source: BASH Inc.).

The need for information about an airport's habitat and associated wildlife before beginning any wildlife control activity is best accomplished by completing a Wildlife Hazard Assessment (WHA) and a subsequent Wildlife Hazard Management Plan (WHMP). These tools are discussed in detail later. In general, these efforts provide the scientific, biologic, and ecologic evidence of the habitat and its wildlife occupants necessary for the airport operator to answer the "who, what, why, where, and when" questions necessary in developing an effective integrated wildlife population management strategy.

WILDLIFE HAZARD ASSESSMENTS AND WILDLIFE HAZARD MANAGEMENT PLANS

Because wildlife poses a significant threat to aviation, airport operators must be prepared to take immediate action to alleviate unexpected incursions of hazardous wildlife into the airport operations area, loading ramps, or parking areas [14 CFR 139.337(a)]. Preparation for this is best accomplished by conducting an airport WHA followed by an FAA-approved WHMP, if necessary.

FAA guidelines sometimes evolve over time as new information becomes available; therefore, airports are advised to consult the most current publications regarding the conduct and content of WHAs and WHMPs. Currently, 14 CFR 139.337(b) requires that, in a manner authorized by the FAA administrator, each certificate holder must ensure that a WHA is conducted when any of the following events occurs on or near the airport:

1. An air carrier aircraft experiences multiple wildlife strikes;
2. An air carrier aircraft experiences substantial damage from striking wildlife;
3. An air carrier aircraft experiences an engine ingestion of wildlife; or
4. Wildlife of a size, or in numbers, capable of causing an event described in paragraph (b) (1), (2), or (3) of this section, is observed to have access to any airport flight pattern or aircraft movement area.

The WHA is conducted by a qualified airport wildlife biologist as per FAA AC 150/5200-36A, who provides the scientific basis for the development, implementation, and refinement of a WHMP. General areas to assess are detailed in FAA AC 150/5200-33B. Although considered separate documents, parts of the WHA may be incorporated directly into the WHMP.

Conducting a WHA, 14 CFR Part 139.337 (c)(2) requires the "identification of the wildlife species observed and their numbers, locations, local movements, and daily and seasonal occurrences." During the WHA, qualified airport wildlife biologists use standardized data collection procedures to

provide an objective assessment of hazardous wildlife in the airport environment that can be repeated in future years for comparative purposes in evaluating wildlife control measure effectiveness.

Once the WHA is complete, it is submitted to the FAA for evaluation and determination of whether a WHMP needs to be developed for the airport. If the FAA determines that a WHMP is needed, the airport operator then formulates and implements a WHMP, using the WHA as the basis for the plan [14 CFR 139.337 (e)(1–3)]. In most cases, a WHMP is necessary and becomes a part of the airport's certification manual that is annually reviewed by the FAA certification inspectors for compliance and implementation.

DEPREDACTION PERMITTING REQUIREMENTS AND PROCEDURES

Before using any wildlife population control measure (e.g., taking migratory birds, dispersing roosts, manipulating nests or eggs, live-trapping, lethal trapping, applying toxicants, and shooting with live ammunition) as part of an airport wildlife management program, airports must first secure a Migratory Bird Depredation Permit from the U.S. Fish and Wildlife Service (USFWS) to comply with federal law. Airports could be advised that state laws are not always consistent with and may be more restrictive than federal law. In all cases, airports must also comply with the individual state's requirements for specific state-regulated species in order to obtain a depredation permit and license from their respective state wildlife management agency, in addition to securing a federal Migratory Bird Depredation Permit.

The first step in obtaining the necessary permits is to contact:

1. The nearest USFWS office.
2. The U.S. Department of Agriculture (USDA)/Wildlife Service (WS) state office.
3. State and local wildlife regulatory and licensing agencies.

Contact information for these agencies is provided by state in Appendix A. An example of a depredation permit and accompanying instructions is provided in Appendix B.

In addition to depredation permits, standing depredation orders are enforced by federal law to allow people to protect themselves and their property from damage caused by migratory birds. Provided no effort is made to kill or capture the birds, a depredation permit is not required to merely scare or herd depredating migratory birds other than threatened and endangered species or Bald or Golden Eagles (50 CFR 21.41). It is paramount that airport personnel properly identify the species involved and that permit conditions and reporting requirements are fully understood. Requirements may vary

significantly, especially at the state and local level. In addition, certain species of migratory birds may be killed or captured without a federal permit under specific circumstances, most of which relate to agricultural situations. Currently, a standing depredation order for airports regarding blackbirds and related species states that “A federal permit shall not be required to control yellow-headed, red-winged, rusty and Brewer’s blackbirds, cowbirds, all grackles, crows, and magpies, when found committing or about to commit depredation upon ornamental or shade trees, agricultural crops, livestock, or wildlife, or when concentrated in such numbers and manner as to constitute a health hazard or other nuisance (50 CFR 21.43).” Aviation safety on airports constitutes such a hazard.

FEDERAL AND STATE AGENCIES WITH WILDLIFE MANAGEMENT RESPONSIBILITIES

Oversight of wildlife population management is regulated and implemented by various federal, state, and local government agencies. Overlapping federal, state, and local regulations enforced by various government organizations protect wildlife and associated wildlife habitat. The following is a listing of the various federal and state agencies and organizations that oversee wildlife population management on or near airports. Agency roles and responsibilities are detailed in Cleary and Dolbeer (2005).

1. U.S.DOT, FAA.
2. U.S. Department of Interior (DOI), USFWS.
3. USDA/WS.

4. U.S. Army Corps of Engineers (COE).
5. U.S. Environmental Protection Agency (EPA).
6. Various state agencies.

FEDERAL AND STATE LAWS AND REGULATIONS

Wildlife population management is protected by overlapping federal, state, and local laws, regulations, and ordinances and enforced by a diversity of governmental regulatory agencies. The following is a listing of the more significant federal regulations and departmental policies that influence wildlife population management on or near airports. Synopses of these federal regulations are detailed in Cleary and Dolbeer (2005).

1. Title 14, Code of Federal Regulations, Part 139 (14 CFR 139).
2. Title 40, Code of Federal Regulations, Part 258.10 (40 CFR 258.10).
3. Title 50, Code of Federal Regulations, Parts 1 to 199 (50 CFR 1-199).
4. Migratory Bird Treaty Act (MBTA) of 1918.
5. Federal Endangered Species Act (ESA) (16 U.S.C. 1531 et seq.) of 1973.
6. Animal Damage Control Act (ADCA) of 1931.
7. Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) of 1947.
8. FAA Advisory Circulars (AC).
9. FAA Airports: Airports Certification Program Policies and Guidance.
10. FAA Airports: Office of Airports Safety and Standards Certalerts.

WILDLIFE POPULATION CONTROL TECHNIQUES

WILDLIFE POPULATION CONTROL

Understanding both the habitat and wildlife found on airports is critical in effective integrated wildlife population management. Wildlife is present at airports because of the availability of food, water, and shelter. As a result, removing, reducing, and eliminating these key habitat attractants is paramount. Examples of habitat modification success and considerations on airports is addressed by Seamans et al. (2007), Bernhardt et al. (2009), Hoen et al. (2009), Linnell et al. (2009), Barclay et al. (2011), Martin et al. (2011), and Carragher et al. (2012). Thus, in most cases, the first and most effective step in wildlife management on airports is habitat modification. This subject is covered in detail in Transport Canada (2002), Cleary and Dolbeer (2005), Cleary and Dickey (2010), and Belant and Martin (2011) and is not detailed in this synthesis. However, it is important to note that the removal of individual animals prior to eliminating these key habitat attractants may eliminate an immediate hazard, but will not provide a long-term solution, as other animals will often replace those that have been removed because suitable habitat still remains (DeFusco et al. 2007).

Under certain circumstances, the removal of wildlife from airports using traps, chemicals, egg and nest removal, and live-ammunition shooting is necessary. Transport Canada (2002) suggested that wildlife removal may be effective in situations in which:

1. The species involved is not mobile and is unlikely to be replaced immediately.
2. The species involved is of a solitary nature with low-density populations unlikely to be found in areas surrounding airports.
3. The immediate removal of a few animals is required expecting short-term effectiveness.
4. A large population of concealed animals (e.g., rodents) must be reduced.
5. The removal of a few animals by shooting enhances the effectiveness of nonlethal frightening tools such as pyrotechnics.

Wildlife population control methods require both political and ethical sensitivity on the part of wildlife control personnel. In all cases, the integrity of the wildlife population management program relies on ethical and respectful treatment of targeted species using acceptable techniques (Gosser et al.

1997; Smith et al. 1999). In addition, safety is paramount and wildlife control personnel should be vaccinated, wear protective heavy gloves at all times, follow procedures that exercise caution against potential animal-borne diseases, and be trained in the proper use of chemicals, firearms, or other equipment. If at any time airport wildlife control personnel are uncomfortable with or cannot follow appropriate safety measures, then professional wildlife exterminators can be consulted and used (Cleary and Dolbeer 2005).

Lastly, because wildlife is afforded various levels of protection under federal, state, and local laws, the importance of consulting with local USFWS, USDA/WS, and state wildlife and environmental agencies before and during wildlife population management planning activities cannot be overstated.

SPECIFIC WILDLIFE POPULATION CONTROL METHODS

In general, wildlife control alternatives are as varied as the species targeted. Once the targeted species or guild is identified, airports must choose the most appropriate wildlife control method to achieve management goals. Direct and indirect wildlife control methods are covered to different degrees by DeFusco and Nagy (1983), Hygnstrom et al. (1994), Harris and Davis (1998), Transport Canada (2002), Cleary and Dolbeer (2005), Cleary and Dickey (2010), and Belant and Martin (2011), and provide excellent references for wildlife population control alternatives and their potential effectiveness.

Prey Control

Wildlife is often present on airports because of the ready availability of food. Certain prey species occupying airport habitat attract predators such as coyotes, foxes, mesomammals, raptors, gulls, egrets, herons, and cranes. In most cases, the targeted prey species include smaller and very abundant organisms such as insects, earthworms, rodents, and fish. However, plant material such as berries, fruits, and seeds can also be considered forage, but are most often controlled using indirect habitat manipulation. If the predator relies strongly on specific prey for food, then predator density on the airport will likely increase with increasing prey numbers. Effective wildlife control measures to reduce prey species include insecticides, pesticides, rodenticides, avicides, fumigants, lethal and nonlethal trapping, and live-ammunition shooting



FIGURE 10 Crop duster applies pesticide to control insect prey at Salt Lake City (SLC) (Source: SLC).

(see Figure 10). As with all wildlife control techniques, airports should consult with the USFWS, USDA/WS, and state and local wildlife regulatory and licensing agencies before initiation to ensure that the control technique is the most appropriate and effective, as well as meets regulatory and depredation permit and licensing requirements (see Figure 11).

Lethal Trapping

Lethal (kill) traps are most often used on small animals; however, they can also be used on larger animals such as beavers, muskrats, and foxes (see Figure 12). In all cases, the appropriate size and type of lethal traps shown to be effective for



FIGURE 12 Small mammal snap trap line set along airport perimeter fence (Source: BASH Inc.).



FIGURE 11 Chemicals (rotenone) used to remove pelican food source (carp) at SLC (left) (Source: SLC) and American White Pelican (right) (Source: BASH Inc.).

the targeted animal or bird species must be used. Lethal traps should be checked frequently to minimize attracting scavenger species and diminish potential ethical and public concerns. Depending on state and local laws, body gripping traps can be used to remove most medium-sized mammals (mesomammals) that create problems at airports. Neck snares can also be used to capture coyotes, beavers, and certain other mammals, but require a high degree of skill and experience to selectively capture the target animals. In all cases, it is important that airport personnel consult reference guides and knowledgeable USFWS, USDA/WS, and state and local wildlife and regulatory agency personnel during trap selection, when establishing a lethal trapping protocol, as well as ensuring that regulatory and depredation permit requirements are met, if necessary. Hygnstrom et al. (1994) and Harris and Davis (1998) provide detailed descriptions of various trap designs for reference.

Live Trapping

Live traps range from simple restraining snares and leg-hold devices to box and barrel traps used for various sizes of animals, from sparrows to bears. For avian-targeted species, Swedish Goshawk traps, bal-chatri traps, walk-in traps, net-guns, starling traps, pole traps, and many others are available. To comply with regulatory requirements, live traps must be checked frequently to evaluate trapping success, minimize captured animal distress, and reduce potential ethical and public concerns when such methods are used. To capture live deer, specialized drop-door traps, drop nets, or rocket net setups can be used; however, live capturing of deer is generally not recommended on airports. Basket or box-type live traps can be used to capture medium-sized mammals such as raccoons, skunks, woodchucks, beavers, and feral dogs (see Figure 13). Leg-hold traps and snares can be used to capture coyotes, feral dogs, and raccoons. Successful mammal trap-



FIGURE 13 Humane trapping of urban scavenger raccoon in a box-type trap at Daytona Beach Airport (DAB) (Source: BASH Inc.).



FIGURE 14 Humane trapping of sedentary birds in walk-in pigeon trap (Source: JFK).

ping, especially with leg-hold traps and snares, requires a high degree of skill and experience. In addition, airports are advised that state and local regulations may restrict the use of some types of traps, as well as the ability to relocate live-trapped animals.

Live traps can be used to capture birds, with those captured either euthanized or removed from the airport and relocated to preapproved areas. Birds can be live-trapped using mist-nets, cage traps, cannon-nets, or large funnel-shaped lead-in traps. Although time consuming and relatively costly, live trapping is most often employed against state and federally protected and high-profile species that are relocated from the airport. In addition, live traps are used to capture sedentary birds such as pigeons and house sparrows (see Figures 14–16). Other birds such as starlings, blackbirds, and crows may also be captured; however, trapping these species



FIGURE 15 By permit, trapping and relocation of Great Horned Owl trapped using Swedish Goshawk trap at Rosecrans Memorial Airport (STJ), St. Joseph, Missouri (Source: STJ).



FIGURE 16 Bal-chatri live trap used for permitted trapping and relocation of federally protected or high profile species (*left*) such as Ferruginous Hawks (*right*) (Source: JFK and BASH Inc.).

is often not an effective method for lowering overall population numbers in the long term. Hygnstrom et al. (1994) and Harris and Davis (1998) provide detailed descriptions of various trap designs. Airport personnel should consult reference guides and knowledgeable USFWS, USDA/WS, and state and local wildlife and regulatory agency personnel during trap selection and when establishing a live trapping protocol, as well as ensuring that regulatory and depredation permit requirements are met, if necessary.

Large mammals, such as deer, can be captured with tranquilizer guns when the use of firearms is not safe or practical. However, the disposition of the captured animal can be problematic. Live capture and relocation of deer is not recommended or allowed in most states because deer populations are at or near carrying capacity and to prevent the possibility of disease transmission. Capturing animals with tranquilizer guns requires personnel with a high degree of skill and experience in their use, as well as, in some cases, certification (Hewitt 2011). When used in an airport environment, safeguards must be in place to ensure that partially tranquilized deer do not enter runway areas or areas in public view. Feral pigs are becoming more of a problem in many areas of the country, particularly in southern states. As with deer, shooting is the preferred strategy for removing pigs from airports. However, where shooting is not allowed or impractical, trapping is the best alternative for capturing and removing

pigs (West et al. 2009). As with other social animals, pigs are susceptible to proper trapping methods and many can be captured in a short period of time. Unlike with some other species, however, most states do not allow trapped pigs to be released into new environments.

Egg/Roost Site Manipulation

Canada Geese, Mute Swans, gulls, and other hazardous species must not be allowed to nest on airport property, and any nests with eggs found at an airport can be destroyed by breaking the eggs and removing nest materials. At the time of nest destruction the adult birds must be dispersed from the airport. It is necessary to check the area weekly for new nesting or re-nesting until the end of the nesting season. Mute Swans and Canada Geese are protected by federal and often state laws. It is important that the nests of pigeons, starlings, and house sparrows also be destroyed whenever they are encountered in airport buildings and structures. These nonnative species are generally not afforded federal protection.

As a long-term approach, egg addling, shaking, oiling (see Figure 17), or puncturing, whereby the birds continue to incubate nonviable eggs, are not generally recommended on airports, as it encourages the nesting birds (and any non-breeding birds associated with them) to remain at the airport, but may be considered in surrounding areas. As an alternative

“Integrating New Technology and Techniques and into Airport Wildlife Control”

Chicago International Airport (ORD)

We are conducting research on various problem bird species to learn more about their movement patterns and airport use, as well as evaluate the effectiveness and/or potential of new wildlife population control tools and techniques. Several studies are ongoing to investigate new technologies, methodologies, and the efficiency of wildlife hazard management. These include:

1. Determining the effectiveness of grid wires over open creek areas.
2. Examining attractiveness of green roofs to wildlife in an airport environment.
3. Determining if the height of pole traps influence species captured and efficiency of trapping.
4. Evaluation/validation of avian radars at a large commercial airport.
5. A mark and re-sight study on Red-tailed Hawks to determine if relocation distance from ORD [Chicago O’Hare International Airport] has any influence on return rate to the airport.
6. Use of GPS [Global Positioning System] satellite transmitters on Red-tailed Hawks to learn about their movement patterns in and around the airport.



Mobile avian radar (Source: BASH Inc.) and Red-tailed Hawk fitted with radio transmitter and wing tag [Source: Portland International Airport (Oregon) (PDX)].



FIGURE 17 Egg oiling at SLC (Source: SLC).



FIGURE 18 Falcon with eggs on ledge in airport hangar at JFK (Source: JFK).

to harassment, any nesting birds could be taken by lethal control or trapping (see Figure 18). Eggs should not be broken as the birds will likely re-nest at another location that may not be found, resulting in a successful hatch being imprinted to the area. Egg addling, shaking, or oiling whereby the birds continue to incubate nonviable eggs can be a very effective long-term method of controlling geese on other public and park land or pond where lethal control is not an option.

Water spray has been used as a direct lethal control method or an indirect method to prevent birds from roosting or nesting in urban and agricultural areas. Water cannons and sprinkler systems, using water or water with wetting agents (surfactants), can be employed to control “pest” birds (see Figure 19). The surfactants allow water to penetrate bird feathers, potentially resulting in death by hypothermia as feathers become wet and body temperatures drop. When applied at night in roost locations, nontoxic surfactants have been successful in local roost control for some abundant species. Surfactants were widely

used for the control of blackbird and starling roosts between 1974 and 1992. Over this period, an estimated 38.2 million blackbirds and starlings were killed through the application of these agents (Dolbeer et al. 1997). In this report, it was shown that surfactant applications did help solve local roost problems; however, the overall population reduction effect beyond the local area was not conclusive and no evidence using North American Breeding Bird Survey data showed that surfactant applications caused declines in regional breeding populations of these species. It is generally accepted that destruction or alteration of the roost site itself, such as by removing trees and brush or preventing access with other deterrents, is more effective than killing birds outright (see Figure 20).

Airport personnel should consult reference guides and knowledgeable USFWS, USDA/WS, and state and local wildlife and regulatory agencies personnel before establishing an egg/roost site manipulation protocol and meet regulatory and depredation permit requirements if necessary.



FIGURE 19 Water cannon use to remove cliff swallow nests under support structures at SLC (Source: SLC).



FIGURE 20 Turkey Vulture roost sites near airports can be managed by removing roost trees (Source: BASH Inc.).

Live-Ammunition Shooting

Firearms are heavily restricted and are to be used only after all other wildlife control methods have failed to produce the required results, or in cases where immediate removal of persistent and problematic animals is necessary (see Figure 21). Both the FAA and USDA support live-ammunition shooting as an “effective practice” for wildlife population reduction (Cleary and Dolbeer 2005).

Shooting birds in an airport environment generally falls into two main categories: quietly or loudly as a reinforcement of audio and visual repellant techniques.

When pigeons use hangars, bridge girders, and other sites they can be shot at night with an air rifle. If done quietly and discretely little disturbance results, allowing the maximum number to be removed. In the second category of shooting, common birds such as gulls and geese that are not responding to various repellent methods can be shot with a 12-gauge shotgun. Although limited in their application, shotguns act in support of scare and dispersal tactics. With flocking birds, the occasional shooting of one bird may be needed to illustrate the significance of loud, sharp noises to the rest of the flock. This is done during daylight and in the open so that other birds are exposed to the audio and visual effects of the shooting.

Shooting birds can have several effects on a flock:

1. It reinforces other audio or visual repellant techniques;
2. The loud noise, coupled with the death of one or more of the flock members can frighten away the rest of the flock; and
3. The target birds are permanently removed.



FIGURE 21 Live ammunition shooting at Dallas/Fort Worth International Airport (DFW) (Source: BASH Inc.).

“Unique Wildlife Control Problems and Applications”

John F. Kennedy International Airport (JFK)

Live ammunition shooting has been used since 1991, primarily targeting numerous gull species that overfly the airport and nest on property adjacent to the airport. Shooting has reduced Laughing Gull strikes by 62% to 99% and other gull strikes by 48% to 88%. In addition, we have received permission to live-ammunition shoot Osprey, a species of special concern. Because local population numbers of Osprey are high, we cannot trap and relocate them. We have received permission to shoot and remove nests of Ospreys that are not responding to nonlethal methods.

Since 2009, problems with diamondback terrapins have been increasing. Trapped animals are measured and micro-chipped and then released to other locations on the airfield. Research on terrapin populations, as well as terrapin deterrents is ongoing.

Canada Geese nesting on the airport have been eliminated using egg oiling, followed by egg and nest destruction. An off-airport wildlife refuge harbors large numbers of Canada Geese, with a population exceeding 1,700 observed during the molt period. Thus, a very effective goose roundup was conducted.



Terrapins awaiting microchip insertion and relocation at JFK (Source: JFK).



Ospreys perched on antenna structure and nest bordering JFK (Source: JFK).

Cleary and Dolbeer (2005) suggest four cardinal rules when considering shooting problem birds:

1. Use only personnel who have an excellent knowledge of wildlife identification and are trained in the use of firearms.
2. Use the proper gun and ammunition for the situation.
3. Have necessary federal and state wildlife kill permits in place, and keep accurate records of killed birds by species and date.
4. Notify airport security, air traffic control (ATC), and, if appropriate, the local law enforcement authority.

Airports are highly encouraged to adopt a “zero tolerance” policy for deer and other large vertebrates at airports. Shooting is the best procedure for removing the deer if fencing is inadequate to keep them away from an airport or if they breached the airport’s fence (see Figure 22) (Hewitt 2011). Nighttime shooting is often the most effective means and can help to keep the program out of public view (see Figure 23). Deer and other large mammals are managed and regulated at the state level. The shooting of deer at airports must be coordinated with the appropriate state wildlife agency to comply with regulatory requirements. In removing large and particularly dangerous ani-



FIGURE 22 White-tailed Deer (left) (Source: STJ) and Black Bear (right) (Source: USDA) deterred from entering airports due to fencing.

mals, firearms may be required to deliver immobilizing drugs. This technique is particularly useful for removing problem bears, which are usually first snared or caught in culvert traps. When using firearms, it is always important to recover empty casings and treat them as FOD, as they can cause serious damage if ingested into turbine aircraft engines.

For maximum effectiveness and safety, integrated wildlife control programs involving firearms require close cooperation among airport staff and skilled field biologists experienced with firearms. If firearms must be used, education programs instituted to raise public awareness are recommended. Airport personnel should consult reference guides and knowledgeable USFWS, USDA/WS, and state and local wildlife and regulatory agency personnel before establishing a live-ammunition shooting protocol, as well as meeting regulatory and depredation permit requirements, if necessary.

Chemical Euthanization (Pesticides, Insecticides, Fungicides, Rodenticides, Fumigants)

Chemicals used to kill wildlife fall into three categories:

1. Acute toxins that kill after ingestion of a single lethal dose.
2. Anticoagulants and decalcifiers requiring the ingestion of several doses over a period of days.
3. Fumigants that suffocate burrowing animals in the ground.

Poisons are generally confined to use on small animals, specifically rodents (Witmer 2011) because:

1. Bait placed in confined areas including burrows is not accessible by other animals (see Figure 24).
2. Small amounts of poison treat large rodent populations at relatively low costs.
3. Problems associated with rodent carcass disposal are minimized, as the carcasses are generally concealed in burrows reducing predator attraction and public concern.

Registered chemicals undergo controlled testing to demonstrate their efficacy and safety. These tests determine:

1. Chemical toxicity.
2. The qualifications required to handle chemical products.



FIGURE 23 Night spotlighting at JFK (Source: JFK).

“Zero-Tolerance Policies for High Hazard Species”

Dane County Regional Airport (MSN)

We have a zero tolerance policy for deer inside the perimeter fence. Since 2006, during March to May of each year, a spring herd reduction is conducted targeting deer observed by aerial observation within 1.5 miles of the airport. We also upgraded to the FAA-recommended 8-ft chain link fence with 2 ft of barbed wire to deter deer entrance onto the airport. Overall, the deer population has been significantly reduced.

Wildlife control measures are approved for Bald Eagles. Regular observations combined with accurate documentation with photos assisted us greatly in expediting the permitting process.



Aerial observations of deer near airport (Source: BASH Inc.).



Aerial and ground-level view of airport perimeter fence at MSN. Note golf course, agriculture, and stands of trees that attract deer and other wildlife near the airport boundary (Source: BASH Inc.).



FIGURE 24 Rodenticides placed in polyvinyl chloride (PVC) pipes to prevent non-target species exposure on airport. Note Burrowing Owls on ground squirrel mound in foreground (Source: BASH Inc.).

3. Potential health hazards.
4. Possible adverse effects on food and drinking water.
5. Overall environmental impact.

In the United States, the oral toxicant, DRC-1339, or Starlicide™ (active ingredient 3-chloro-p-toluidine hydrochloride) is currently the only product registered with the EPA for use in bird population management. Starlicide (0.1% active ingredient) is formulated in a pellet bait for use at feedlots to control starlings and blackbirds. DRC-1339 (98% active ingredient) can be formulated with a variety of baits and used to control starlings, pigeons, gulls, ravens, house sparrows, and blackbirds under certain conditions, some of which might be applicable at airports. The control of pigeons around airport buildings and starlings roosting at or near an airport are the situations most likely applicable. Only USDA/WS personnel or persons working under their direct supervision can use DRC-1339.

The use of toxic baits to kill target birds without affecting nontarget species requires considerable skill and patience. Daily movement patterns of the target birds among feeding, loafing, and roosting sites must be determined so that attractive bait sites that are controlled to prevent public access (such as a roof top) can be selected. The proper bait (a highly desired food) must be selected and the sites then pre-baited, often for a week or more, to ensure good bait acceptance and that nontarget animals are not visiting the bait site. Proper pre-baiting is the most critical step of a successful program. Caution must be exercised in an airport environment as pre-baiting is designed to attract birds to the control site and may compromise flight safety if not properly placed. During the baiting period, all uneaten bait must be removed daily to avoid affecting nontarget species. With DRC-1339, birds typically die one to three days after bait ingestion; therefore, areas surrounding bait sites will need to be searched for several days after baiting to remove dead birds.

If den locations are known, fumigation can be used to manage coyotes and other predators. Burrowing rodents such as woodchucks (groundhogs) and prairie dogs can be killed by fumigation of burrows with either gas cartridges or zinc phosphide tablets. Before fumigation, it is imperative that burrows are monitored to ensure that the targeted species occupy the location and other nontarget species will not be affected. Gas cartridges, ignited from a burning fuse after placement in the burrow, generate carbon monoxide at fatal levels. Zinc phosphide pellets react with moisture in the burrow to produce phosphine gas, also at fatal levels. It is necessary to plug all burrow entrances with sod after placement of the cartridge or pellets in the burrow. Gas cartridges are a general use, over-the-counter pesticide. Zinc phosphide pellets can only be applied by certified pesticide applicators and might not be available in all states. As with all pesticides, it is critical to make sure the chemical targeted at the hazardous wildlife species treated is registered by the state. Occasionally, propane pumped into burrow systems, sealed, and then ignited is employed, but many airports consider this a potentially dangerous option and prefer not to use this technique.

Knowledge of proper handling methods is critical to ensure the safety of the user, but also the environment and nontarget species. All chemical pesticide product labels include safety precautions and instructions for use. These products must be used only as directed and to meet regulatory requirements. If not used properly, poisons may seep into soil and ground water, poisoned animals may be consumed by predators, and toxic carcasses could be eaten by scavengers that may potentially result in secondary poisoning. Thus, proper placement of poisons is critical, as well as the immediate removal of exposed dead animals. Although definitive information on the secondary effects of acute poisons is inconclusive, current research indicates that scavengers are not likely to be seriously affected by eating the

carcasses of rodents killed by anticoagulants. However, in areas occupied by endangered species, the possibility exists that nontarget species may eat baits targeting rodents. This concern can be reduced by using enclosed bait stations that also provide protection from inclement weather. All chemicals used in pest control including those employed to manage wildlife must be registered with the EPA, USDA/WS, and state regulatory agencies. This includes chemical herbicides (weed control), insecticides (insect control), fungicides (mold and fungi control), as well as all animal and insect chemical repellents.

WILDLIFE POPULATION CONTROL EFFECTIVENESS

Direct wildlife population control measures on airports are often not used because of concerns about the effect of such actions on the overall species populations outside the airport boundaries (see Figure 25). The population of a particular species on an airport is part of a larger-scale local, state, regional, and continental population, or metapopulation. Healthy wildlife populations remain relatively stable through a balance in reproduction with a variety of natural mortality factors. These factors include predation, disease, parasites, starvation, aging, and intra- and inter-specific competition. In populations approaching their carrying capacity, an increase in any one mortality factor is generally offset by a reduction in other factors including potential increases in reproductive success. This population-level response is known as “compensatory mortality” (Ricker 1954). For example, if increased predation were to occur, the remaining population is compensated by lessened competition for resources and therefore reductions in mortality directly from that competition, or indirectly from disease transmission or starvation in response. State and federal agencies structure their hunting seasons and quotas to maintain sustainable populations based on these principles. Many studies are detailed in the literature as described in the following examples. From 1974 to 1992 an estimated 38.2 million blackbirds and starlings were killed in the southern United States by surfactant applications to winter roosts (Dolbeer et al. 1997). These management operations had no detectable impact on subsequent nesting population levels in the northern United States (Dolbeer et al. 1997). The greatest number of birds removed during a single winter was 4.2 million Common Grackles in 1977. A simulation with population models of the annual population cycle of Common Grackles in the eastern United States demonstrated the minimal impact of removing 4.2 million birds during January. From 1991 to 1997, biologists shot 47,600 Laughing Gulls flying over JFK airport from May to August, reducing gull strikes by 66% to 89% (Dolbeer and Bucknall 1998). Neither the national or northeast regional (Virginia to Maine) population of Laughing Gulls declined during the years of the shooting program, based on North American Breeding Bird Survey results from 1966 to 1996 (Burger 1996; Sauer et al. 1997). From 1991 to 2008, 101,832 gulls were killed

“Wetland Mitigation Success”

Rosecrans Memorial Airport (STJ)

We removed approximately 180 acres of cattails that border the airport on the southern and western edge. Using a contracted aerial sprayer, we achieved a 100% cattail kill rate using aquatic herbicide. This resulted in dramatic reductions in various waterfowl and blackbirds that were previously attracted to the cattail habitat.



Extensive wetland habitat and cattail marsh surrounding STJ (Source: BASH Inc.).



Cattails before and after application of herbicide to remove habitat used by various species at STJ (Source: STJ).



FIGURE 25 Standing water and cattail growth along edge of airfield drainage ditch (Source: BASH Inc.).

(2,263–14,866/year), comprised of 88,009 Laughing Gulls and 13,823 other gulls. The number of aircraft striking Laughing Gulls was reduced by 62% in 1991 and 76% to 99% annually from 1992 to 2008, compared with the mean of 157 strikes/year from 1988 to 1990 (Washburn et al. 2009). Overall, populations demonstrate compensatory mortality in response to population reductions on airports

allowing for the reduction of local population numbers on the airport with negligible effects to the overall metapopulation (Ricker 1954; Dolbeer et al. 1993, 1997; Dolbeer 1998). Thus, with few exceptions, airports should not be concerned that their actions will have dramatic negative consequences on the populations of the target species outside the airport boundaries.

ENDANGERED SPECIES AND GAME VERSUS NON-GAME WILDLIFE POPULATION MANAGEMENT ISSUES

ENDANGERED SPECIES

There can be potential confusion in the application of wildlife control measures on airports when dealing with federal- and state-listed species, as well as game versus non-game state designations of wildlife. Wildlife control measures can be used on problematic federal and state-listed species with the proper permits in place. The Federal Endangered Species Act (ESA) [16 U.S.C. 1531 et seq.] of 1973 provides for the listing, conservation, and recovery of endangered and threatened species of plants and wildlife (see Figure 26). Section 7(a)(2) of the ESA states that federal agencies shall ensure that actions it authorizes, funds, or carries out are not likely to jeopardize the continued existence of a listed species or result in destruction or adverse modification of designated critical habitat. Section 9 of the ESA prohibits the take of listed species, although exceptions may be granted with appropriate permits. Take is defined by the ESA as “to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect.” The definition of harm further includes adverse habitat modification. Federal actions that could result in take, but not jeopardize or adversely modify habitat, must still be coordinated under Section 7. The minimal biological evaluation under Section 7 of the ESA requires the determination of the presence of listed or proposed species or critical habitat on or near the airport. If protected species or habitats are known not to occur, the environmental analysis with respect to the ESA is complete. Airports can work cooperatively with the regulatory agencies to ensure that aviation safety is not compromised by the presence of protected species. The presence of such species on airports can not only jeopardize safety, but can also have potentially adverse effects on the species being protected, as they may become involved in aircraft collisions (see Figure 27).

When preparing a WHMP, the local USFWS Ecological Services field office can provide information about the presence of federally listed or proposed threatened and endangered species or designated or proposed critical habitat on or near the airport (see also FAA AC Policy #78, Section-7 Consultation on Endangered or Threatened Species). This information is frequently updated and can also be found on the regional USFWS or state natural resources agency websites (see Appendix A). The USFWS may forward a response to the airport operator to be taken into account when preparing the WHMP. If federally listed or proposed threatened and endangered species or designated or proposed critical habitat are present, the airport operator may be required to prepare a Biological Assessment (50 CFR 402.13) to determine the impacts of the WHMP on

these species or habitats. The Biological Assessment and draft WHMP is submitted to the FAA for review and approval. In addition, the FAA may conduct or direct any needed Section 7 consultations with the USFWS. State-listed species are not afforded the same level of federal protection, but are to be addressed in the preparation of a WHMP. State-listed species are not to be encouraged and are often exempted from protection on airports as per FAA Cert Alert 06-07 and other relevant advisory circulars.

GAME VERSUS NON-GAME SPECIES

Title 50, Code of Federal Regulations, Parts 1 to 199 (50 CFR 1-199) govern the management of federally protected wildlife within the United States and its territories based on the authority established in the Migratory Bird Treaty Act. These regulations also establish procedures for issuing permits to take federally protected species. Federal law protects all migratory birds, including their nests and eggs. A federal depredation permit, issued by the USFWS, must be obtained before any non-game migratory birds may be taken, or before any migratory game birds may be taken outside of the normal hunting season or beyond established bag limits. This encompasses almost all native bird species in the United States, with the exception of nonmigratory game birds, such as Wild Turkeys and various grouse, ptarmigan, and quail, as well as some introduced game birds, such as Ring-necked Pheasants and Chukars. Exotic and feral species, such as Graylag Geese, Muscovy Ducks, European Starlings, House (English) Sparrows, and Rock Pigeons, are not listed in 50 CFR 10.13 and are therefore not protected by federal law.

In addition to federal protection, all states protect migratory birds as well as game birds. The protection of exotic or feral species varies by state. With the exception of federally listed or proposed threatened or endangered species, federal law does not protect terrestrial mammals, reptiles, or other wildlife taxa (e.g., deer, coyotes, foxes, raccoons, groundhogs, snakes, turtles, and freshwater fish). Protection of these wildlife groups is left to the individual states. Local ordinances may afford additional protections. In all cases, airports must ensure that they understand both the federal and state requirements and obtain the appropriate permits and licenses before any wildlife control is initiated (see Figure 28). It may be required for airports to consult the appropriate federal, state, and local regulating agencies (Appendix A) before proceeding with any direct wildlife population control measures.



FIGURE 26 Federally endangered and protected Hawaiian Goose (top). Burrowing Owl (bottom) is not given the same protection under MBTA and as state-listed species of special concern (Source: BASH Inc.).



FIGURE 27 Jet engine destroyed by federal- and state-protected Burrowing Owl (Source: BASH Inc.).



FIGURE 28 Wild Turkeys managed at the state level as game birds and Gray Fox state-managed as a furbearer/small game species (Source: BASH Inc.).

CONTROL METHODS FOR INDIVIDUAL SPECIES AND WILDLIFE GUILDS

SPECIES-LEVEL AND GUILD-LEVEL WILDLIFE POPULATION CONTROL METHODS

The following is a listing of potential direct and indirect wildlife population control measures used on airports as part of an integrated wildlife management strategy. Information is provided for several individual “high-risk” species followed by both avian and mammalian guilds. Guilds are defined as groups of different species that generally occupy similar habitats or niches and behave similarly, but do not necessarily follow traditional taxonomic relationships. Thus, wildlife control measures are similar for different species within the same guild. As previously discussed, the appropriate lethal and live traps in trapping operations and the appropriate firearms in live-ammunition shooting must be used, although not all methods are necessary for all species and not all species pose risks to aviation operations. Although habitat modification is considered an indirect control method, it is included within this section because it is a critical component of integrated wildlife population control. Active harassment is not specifically detailed, but is appropriate for virtually all species and guilds.

Species Level

Canada Geese

- Habitat modification
- Turf management
- Water/drainage management
- Agricultural management
- Egg and nest manipulation
- Live trapping (includes roundups) (see Figure 29)
- Live-ammunition shooting.

Cattle Egrets (see Figure 30)

- Habitat modification
- Turf management
- Water/drainage management
- Roost removal
- Prey reduction (insects)
- Falconry/canines
- Live-ammunition shooting.

Bald Eagles (see Figure 31)

- Habitat modification
- Turf management
- Water/drainage management
- Solid waste management
- Removal of nests and nest trees
- Prey reduction (fish, rodents, rabbits, mesomammals).

White-tailed Deer (see Figure 32)

- Habitat modification
- Turf management
- Forest management
- Water/drainage management
- Agricultural management
- Exclusion (fencing)
- Live trapping
- Live-ammunition shooting.

Coyotes (see Figure 33)

- Habitat modification
- Turf management
- Forest management
- Water/drainage management
- Solid waste management
- Exclusion (fencing)
- Prey reduction (rodents, rabbits, mesomammals, eggs)
- Lethal trapping
- Live trapping
- Live-ammunition shooting
- Chemical euthanasia (den fumigation).

Avian Guild Level

Waterfowl (ducks, geese, swans) (see Figure 34)

- Habitat modification
- Turf management
- Water/drainage management
- Agricultural management
- Prey reduction (fish for piscivorous species)
- Live trapping
- Live-ammunition shooting.

Pelicans and cormorants (see Figures 35 and 36)

- Habitat modification
- Water/drainage management
- Prey reduction (fish)
- Live trapping
- Live-ammunition shooting.

Grebes and coots (see Figure 37)

- Habitat modification
- Water/drainage management
- Prey reduction (fish for grebes)
- Live trapping
- Live-ammunition shooting.

Wading birds (egrets, herons, cranes) (see Figure 38)

- Habitat modification
- Turf management
- Water/drainage management



FIGURE 29 Canada Geese roundup (Source: SLC) and nesting Canada Goose at SLC (Source: BASH Inc.).



FIGURE 30 Cattle Egrets in flight over airport and foraging during mowing operations (Source: BASH Inc.).



FIGURE 31 Bald Eagle taking off at MSN (Source: MSN).



FIGURE 32 White-tailed Deer (Source: BASH Inc.).



FIGURE 33 Coyotes (*Source: BASH Inc.*).



FIGURE 34 Snow Geese outside Klamath Falls International Airport (LMT) (*Source: BASH Inc.*).



FIGURE 36 Double-crested Cormorant loafing on canal bordering airport (*Source: BASH Inc.*).



FIGURE 35 American White Pelicans and Brown Pelican (*Source: BASH Inc.*).



FIGURE 37 American Coots and Least Grebe (Source: BASH Inc.).



FIGURE 38 Various wading birds on airports (Source: BASH Inc.).

- Roost removal
- Prey reduction (fish, rodents, insects)
- Live trapping
- Live ammunition shooting.
- Gulls (see Figure 39)
 - Habitat modification
 - Turf management
 - Water/drainage management
 - Solid waste management
 - Nesting site management
 - Prey reduction (earthworms, insects)
 - Chemical avicides
 - Lethal trapping
 - Live-ammunition shooting.
- Shorebirds (sandpipers, plovers, avocets, and others) (see Figure 40)
 - Habitat modification
 - Turf management
 - Water/drainage management
 - Prey reduction (insects, other invertebrates)
 - Egg/nest removal
 - Live trapping
 - Live-ammunition shooting.
- Raptors (hawks, falcons, eagles, owls, osprey, vultures) (see Figures 41 and 42)
 - Habitat modification
 - Turf management
 - Water/drainage management
 - Roost removal
 - Nest destruction
 - Prey reduction (rodents, insects, rabbits, mesomammals, fish for eagles and ospreys, carrion for vultures)
 - Live trapping
 - Live-ammunition shooting.
- Doves and pigeons (see Figures 43 and 44)
 - Habitat modification
 - Turf management
 - Forest management
 - Water/drainage management
 - Agricultural management
 - Reducing bare areas, gravel, and grit
 - Facilities/buildings management
 - Prey reduction (seeds)
 - Chemical avicides
 - Live trapping
 - Live-ammunition shooting.
- Blackbirds and starlings (see Figures 45 and 46)
 - Habitat modification
 - Turf management
 - Water/drainage management
 - Roost site management
 - Agricultural management
 - Prey reduction (insects, seeds)
 - Live trapping
 - Live-ammunition shooting

- Chemical avicides
- Surfactant treatment at roost sites.
- Corvids (crows and ravens) (see Figure 47)
 - Habitat modification
 - Turf management
 - Water/drainage management
 - Roost site management
 - Solid waste management
 - Agricultural management
 - Prey reduction (insects, rodents, rabbits, mesomammals, eggs)
 - Chemical avicides
 - Live trapping
 - Live-ammunition shooting.
- Aerial foragers (swallows, flycatchers, and nighthawks) (see Figure 48)
 - Habitat modification
 - Turf management
 - Forest management
 - Water/drainage management
 - Nest site management
 - Facilities/buildings management
 - Prey reduction (insects)
 - Nest and egg manipulation.
- Grassland passerines (meadowlarks, sparrows) (see Figure 49)
 - Habitat modification
 - Turf management
 - Nest removal
 - Prey reduction (insects, seeds)
 - Live trapping.
- Woodland birds (songbirds, woodpeckers) (see Figure 50)
 - Habitat modification
 - Forest management
 - Prey reduction (insects, seeds, fruits, berries)
 - Live trapping.

Mammalian Guild Level

- Predators (foxes, bobcats, badgers, bears, etc.) and feral animals (dogs, cats, pigs, etc.) (see Figure 51)
 - Habitat modification
 - Turf management
 - Water/drainage management
 - Solid waste management
 - Agricultural management
 - Exclusion (fencing)
 - Prey reduction (rodents, rabbits, mesomammals, eggs)
 - Burrow system fumigants
 - Live trapping
 - Lethal trapping
 - Live-ammunition shooting.
- Mesomammals (skunks, raccoons, opossums, etc.) (see Figure 52)
 - Habitat modification
 - Turf management
 - Forest management



FIGURE 39 Gulls loafing on airport parking ramp and Ring-billed Gull detail (Source: BASH Inc.).



FIGURE 40 Killdeer on taxiway shoulder and American Avocets foraging on airport wetlands (Source: BASH Inc.).

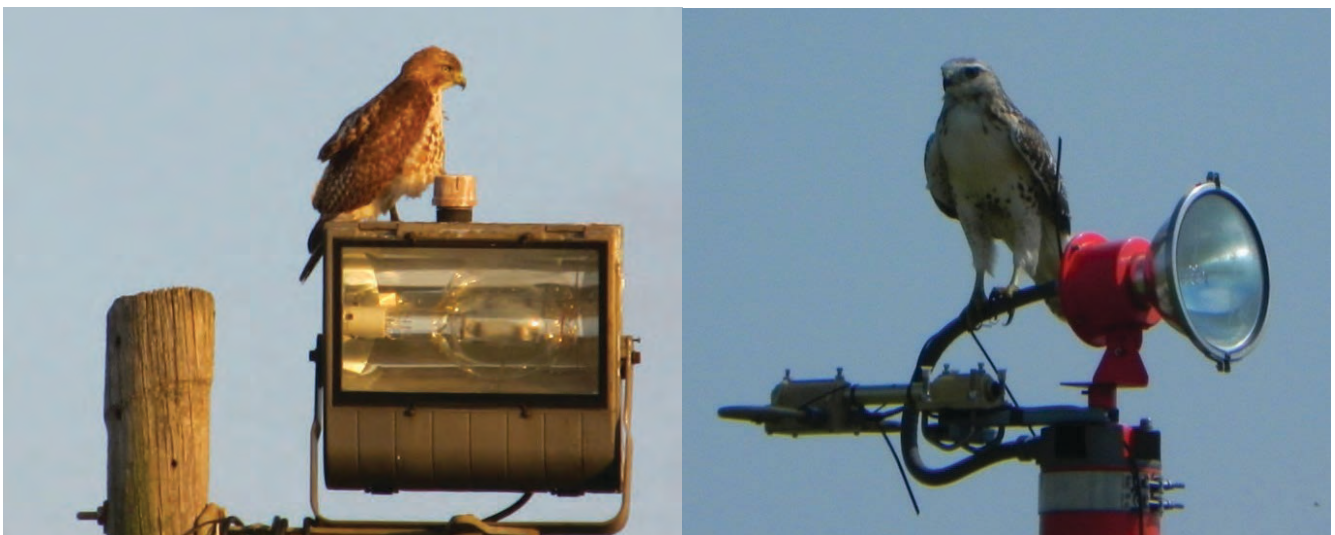


FIGURE 41 Red-tailed Hawks perched on airport lighting structures at Jack Brooks Regional Airport (BPT) (left) (Source: BASH Inc.) and Dane County Regional Airport (MSN) (right) (Source: MSN).



FIGURE 42 Turkey Vultures at Orlando International Airport (MCO) (left) (Source: MCO) and Snowy Owl at MSN (right) (Source: MSN) perched on airport structures.



FIGURE 43 Mourning Doves loafing on airport perimeter fence and gritting behavior (Source: BASH Inc.).



FIGURE 44 Rock Pigeons near airport terminals (Source: BASH Inc.).



FIGURE 45 European Starlings loafing on telephone wires and returning to roost sites just outside airports (Source: BASH Inc.).



FIGURE 46 Blackbird flock dispersal on airport (Source: Peloton Land Solutions).



FIGURE 47 Common Raven scavenging on rabbit (Source: BASH Inc.).



FIGURE 48 Cliff Swallows nesting on hangar (left), Common Nighthawk (middle), and Scissor-tailed Flycatcher (right) (Source: BASH Inc.).



FIGURE 49 Eastern Meadowlark on airport utility box, sparrow on airfield light (Source: BASH Inc.).

- Water/drainage management
- Solid waste management
- Prey reduction (rodents, rabbits, eggs)
- Live trapping
- Lethal trapping
- Live-ammunition shooting.
- Lagomorphs (rabbits, hares) (see Figure 53)
- Habitat modification
 - Turf/shrub management
 - Forest management
 - Water/drainage management
- Fencing (exclosures)
- Live trapping

- Lethal trapping
- Live-ammunition shooting.
- Rodents (mice, rats, voles, gophers, moles, ground squirrels, prairie dogs, etc.) (see Figure 54)
- Habitat modification
 - Turf management
 - Water/drainage management
- Exclusion with barrier fences for colonial rodents
- Prey reduction (insects, seeds)
- Chemical rodenticides
- Burrow-system fumigants
- Live trapping
- Lethal trapping
- Live-ammunition shooting.



FIGURE 50 Representative woodland birds: Northern Mockingbird (left), Northern Cardinal (middle), Black-throated Green Warbler (right)(Source: BASH Inc.).



FIGURE 51 Predators and feral animals on and near airports (Source: BASH Inc.).



FIGURE 52 Opossum live trapped at Daytona Beach International Airport (DAB) (left); badger (middle); striped skunk (right) (Source: BASH Inc.).



FIGURE 53 Jackrabbits near airport taxiway and under radar structure at JFK (Source: JFK).



FIGURE 54 Black-tailed Prairie Dogs and Uintah Ground Squirrel on airports (Source: BASH Inc.).

AIRPORT WILDLIFE MANAGEMENT CASE STUDIES AND LESSONS LEARNED

POPULATION MANAGEMENT CASE STUDIES

Using input from our wildlife population control management surveys provided by the airport operators, the key points and lessons learned were summarized and consolidated from the application of direct and indirect wildlife population control techniques as part of an integrated approach.

Special thanks go to the following airports and personnel for their survey input.

- FAA Alaska Region
Ketchikan International Airport (KTN),
Ketchikan, AK
- FAA Central Region
Rosecrans International Airport (STJ),
St. Joseph, MO
- FAA Eastern Region
John F. Kennedy International Airport (JFK),
New York, NY
- FAA Great Lakes Region
Minneapolis/St. Paul International Airport (MSP),
Minneapolis/St. Paul, MN
Chicago O'Hare International Airport (ORD),
Chicago, IL
Dane County Regional Airport (MSN), Madison, WI
- FAA New England Region
Burlington International Airport (BTV),
Burlington VT
- FAA Northwest Mountain Region
Salt Lake City International Airport (SLC), Salt
Lake City, UT
Denver International Airport (DEN), Denver, CO
Colorado Springs Airport (COS), Colorado
Springs, CO
- FAA Southern Region
Orlando International Airport (MCO), Orlando, FL
Charlotte Douglas International Airport (CTL),
Charlotte, NC
- FAA Southwest Region
Dallas/Fort Worth International Airport (DFW),
Dallas/Fort Worth, TX
- FAA Western Pacific Region
Seattle–Tacoma International Airport (SEA),
Seattle, WA
Reno–Tahoe International Airport (RNO), Reno, NV

Initiation of Wildlife Population Control

Before initiating any wildlife population control measure, it is critical to identify the who, what, where, when, and why for the wildlife on the airport. Initially, this information is best gathered through a WHA. Information concerning the habitat attractors of wildlife, combined with the current wildlife identification, abundance, and distribution on the airport are critical in developing a WHMP. Wildlife information can also be gathered from the FAA's Wildlife Strike Database, airport staff wildlife counts and surveys, as well as wildlife sightings from airport operations personnel, ATC, pilot reports, and other tenant units.

Wildlife Control Methods

All wildlife population control methods were used by respondent airports dependent on the targeted species. In all cases, airports identified the initial need to determine habitat attractiveness and subsequent residency and occupation by targeted species and guilds. Next, an integrated approach is used beginning with habitat modification and followed by indirect wildlife control methods and appropriate direct wildlife population control techniques. Wildlife population control measures are often more costly than indirect measures because of equipment cost, personnel time, and expertise. In all cases, the costs of wildlife control are secondary to safety.

Effectiveness

The most obvious metric to evaluate wildlife population control effectiveness is a reduction in wildlife strikes for the targeted species or guild. However, wildlife census counts conducted with regular frequency and then evaluated using systematic procedures can provide accurate measures of technique effectiveness. Without such procedures in place, the ability to discern actual population changes is not possible. Airports should use all possible wildlife data sources to include those listed previously in wildlife control initiation.

LESSONS LEARNED

The following are excerpts from respondent airport surveys that provided input to the following question from the survey,

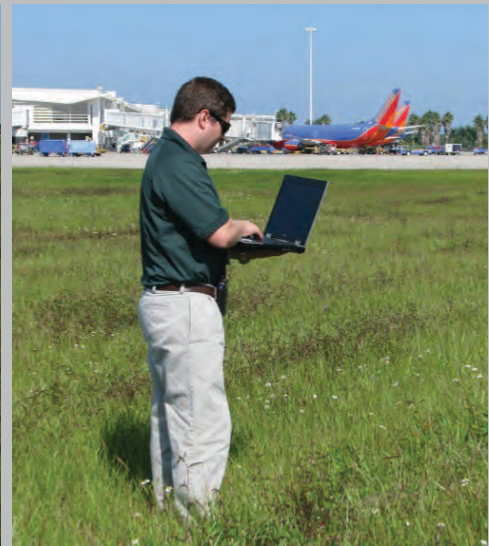
“Importance of Data Collection and Analysis”

Orlando International Airport (MCO)

Strike data, (damaging and non-damaging) combined with daily wildlife activity reports, can provide an accurate description of bird and wildlife activity on and near the aircraft operating area, and highlight the most hazardous species. Further analysis can reveal the location, time of day, and time of year when these species are most likely to occur. Sandhill Cranes, Cattle Egrets, Ring-billed Gulls, and vultures (Turkey and Black) were clearly identified as more hazardous than approxi-

mately 30 other species regularly encountered. An integrated approach of habitat manipulation, selective nest elimination, species specific harassment, and time and location specific lethal removals have resulted in a decreasing trend in damaging strikes and a reduction in population observed on airport property.

This analysis and evaluation conducted annually provides the basic elements for a Safety Management System framework specific to wildlife hazards. Data are acquired, analyzed, the system assessed, corrective action implemented, and the system re-evaluated.



Data collection by wildlife control personnel at MCO (Source: MCO).

“Please provide any additional comments from your wildlife population management experiences that may assist others with their wildlife population management planning and implementation.”

Take an Integrated Approach to Wildlife Management

Be aware of and understand the consequences of all federal, state, and local regulations before initiating wildlife population management.

Identify potential wildlife attractants not only on the airfield but surrounding the airfield as well, and work to mitigate hazards as needed.

Use an integrated wildlife management strategy (toolbox approach) where a variety of techniques are used to maximize effectiveness rather than reliance on one specific technique. The more tools and flexibility you have, the sooner

you will determine what works at your airport. There is no “cookie cutter” answer for every airport’s wildlife population. Habitat modification is the foundation of our strategy followed by specific direct and indirect measures. Communicate with others within the industry and see what has worked or not worked for them, and use this information to develop your own plan.

Effective wildlife population management depends on education and communication. Most people understand the necessity for wildlife management on airports through education of the hazards posed to aviation by wildlife. Work with tenants and local neighbors in the educational process.

Trust the Experts

Consult with a qualified airport wildlife biologist prior to implementing a wildlife hazard management plan.

Trust your wildlife biologists!

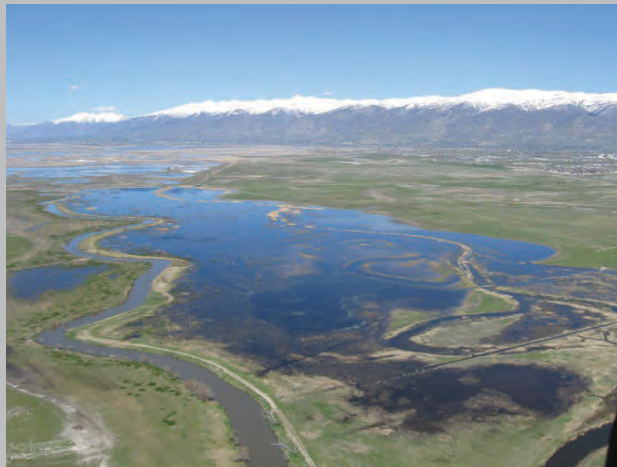
“Integrated Wildlife Control On and Off Airport”

Salt Lake City International Airport (SLC)

Numerous bridges associated with a large canal support large colonies of nesting Cliff Swallows. Netting was installed as an exclusion method combined with using the airport fire trucks to spray swallow nests prior to egg laying. Persistent re-nesting attempts required repeated spray efforts.

Up to 10,000 California Gulls were nesting 1.5 miles from the airport resulting in frequent airport over-flights. The gull colony was eventually removed using nest disruption, harassment, and by placing domestic pigs to predate gull eggs.

Off-airfield water areas owned by duck hunting clubs have had the chemical rotenone applied to eliminate fish prey, mostly carp, which attract high concentrations of foraging American White Pelicans. This prey reduction has decreased pelican numbers and resultant risk potential.



Extensive wetland habitat surrounding airport (Source: BASH Inc.) and pigs used to predate gull eggs at SLC (Source: SLC).

Importance of Public Support and Communication

Press releases may be issued before starting sensitive projects, such as goose roundups, to inform the community on what was happening and why. Because the city and mayor were involved and supportive, public sentiment and approval was increased. Many were only upset that the goose meat wasn't donated; with a change to state regulations, this was made possible two years later.

Participation in outreach opportunities when possible to explain the threats wildlife pose to aviation safety and the importance of wildlife hazard management at airports. Awareness of the wildlife hazard is a key issue and administrative support is also a major component in providing funding and resources for a successful WHMP.

Networking with local wildlife, environmental, and conservation organizations and agencies can provide much needed wildlife expertise and resources. Take advantage of the National Strike Database. It is important that primary bird and wildlife aviation threats be identified before initiation of a wildlife strategy. The most populous or noticeable species may not necessarily be the primary threat to aviation.

Coordinating and teaming with other municipalities can help defray costs, reduce some administrative restrictions, increase potential resources (park police, biologists, extra staff), and may help broaden support for a potentially sensitive project.

Evaluate Your Actions to Determine Wildlife Population Control Effectiveness

Accurate record keeping of wildlife activities, sightings, strikes, and direct control methods is the primary way to ensure continued effectiveness of wildlife population management at our airport. With accurate records we can observe trends from month to month and year to year and measure the effectiveness of control measures that are implemented on specific targeted wildlife populations. This allows us to better anticipate what species will present an increased hazard and eventually implement measures to be proactive before it becomes a major problem. These data can also be used to educate personnel directly involved in wildlife control at our airport to identify problem species and methods to more effectively control them.

Bi-monthly wildlife point-count surveys of the airfield are conducted and we use these data to identify cyclical behavior

patterns, population trends of various hazardous wildlife species, as well as aiding in wildlife management decisions and efforts.

All indirect and direct wildlife control activities are recorded and entered into an electronic database. These wildlife control data are then used for long-term evaluation of various airport wildlife management decisions.

Wildlife activity is reported and documented on the Airfield Activity Daily Log, with report copies maintained for 5 years. Annually, these data are analyzed to determine which species are encountered most often in the runway environment, where they most often occur on the airport operations area, and the time of year these species are most frequently encountered.

Evaluating and comparing annual reports reveals trends in individual species activity, their location, frequency of occurrence, and average population per occurrence. This information is also used for annual wildlife training of airfield operations personnel to provide them with specific wildlife guidance while performing their routine inspection duties in and around the runway environment. The annual reports also allow us to gauge long-term program effectiveness.

When requesting a permit or permit renewal, try to plan for the worst-case scenario. If you have been seeing 5 deer and 5 turkeys, request a permit for 15 deer and 15 turkeys (you are most likely underestimating the population). I have had to amend both the federal depredation and state depredation permits mid-year because of an unexpected situation based on population estimates.

Records are kept on all population management efforts including the length of the control activity, species controlled, and number of each species controlled.

Continuous Improvement

Adding a research component to a wildlife control project can also help reduce public sensitivity and garner support from conservation-minded officials. This helps to provide data for the project that can later be used to support your methods and evaluate overall effectiveness.

A successful wildlife control program is dependent on determined and resourceful personnel whose efforts are based on the knowledge of wildlife biology and behavior. Continuous efforts with administrative support will make a noticeable difference in an effective WHMP.

Airport management must remain flexible when dealing with wildlife management and overall effectiveness. Methods that worked one year may not work the next. There is always new technology, but spending more money on new “holy grails” to eliminate a bird population isn’t always the answer. Adaptive management strategies that address new situations or respond to analysis of data are necessary to continually improve.

CONCLUSIONS AND INFORMATION NEEDS

Airport integrated wildlife population management programs use both indirect nonlethal habitat management (harassment, repellent, and deterrent techniques) combined with appropriate direct lethal and nonlethal wildlife population control methods (e.g., prey reduction, pesticide applications, live trapping, and live-ammunition shooting when necessary). To maximize the effectiveness of wildlife population control, the integrated approach would account for the ecology of the targeted species or guild to ensure that habitat attractiveness is minimized and the targeted population reduced. Although habitat management and harassment techniques are more widely used by airports and are more generally accepted by the public, nonlethal and lethal wildlife population control measures are commonly used when immediate or more aggressive control measures are warranted. An effective integrated wildlife population management program using both lethal and nonlethal population control methods can produce synergistic effects that outperform singular method strategies.

Population control is accomplished in accordance with all federal and state regulations and specifically by permit for species of special attention. Because of the significant investment in time, effort, and cost associated with direct wildlife population control measures, it is paramount to also systematically collect data necessary to evaluate the overall effectiveness of such control measures. It is important that airports follow historic wildlife damage control and game management programs to increase and improve their wildlife population census activities for a systematic approach in determining the effectiveness of wildlife control. In addition, adaptive management strategies are best tailored to the results of these analyses consistent with Safety Management Systems principles.

Reports on the effectiveness of nonlethal and lethal control measures in the literature, particularly in airport environments, is limited. Although expected outcomes are often assumed to be consistent with agricultural wildlife damage control and game-management principles, more rigorous experimental designs at pertinent spatial scales are necessary.

Several areas of research are needed in the field of reducing wildlife hazards to aviation. Recommended research initially could focus on:

1. Determination of criteria for data collection needed to assess wildlife population management tools and technique efficacy.
2. Development of industry standard procedures to perform wildlife risk assessments for use by airports.
3. Determination of best management practices for conducting and developing Wildlife Hazard Assessments and Wildlife Hazard Management Plans that incorporate risk assessments.
4. Threatened and endangered species issues at the federal and state level affecting wildlife hazards to aviation.
5. Development of airport wildlife hazard management into the International Civil Aviation Organization and FAA standards for Safety Management Systems.
6. Development of standards and regulations for operators to reduce wildlife hazards to aviation that would specifically target pilots, air traffic controllers, communication networks, airline training procedures, and other operational stakeholders.
7. Development and testing of new and emerging technologies for use in wildlife risk management to include remote sensing, communications technologies, and other methods for airport operations managers, air traffic controllers, and airborne aircrews.
8. Development and implementation of a singular comprehensive wildlife hazard management strategy that incorporates all aspects of the issue including regulatory requirements and recommendations for airport management, community land use planning, wildlife control, aviation operations, communications, air traffic control procedures, aircrew responsibilities, and other stakeholder requirements.

Although much progress has been made in the field of reduction of wildlife hazards to aviation, there is still much to do. Wildlife population control programs as outlined in this synthesis address many of the issues faced by airport operators and are accepted practice that are suggested for implementation where applicable. Additional research efforts are needed to provide further understanding of wildlife population control program effectiveness and help develop a more thorough, comprehensive, and integrated framework to assist airport operators, biologists, and aviators in reaching the ultimate goal of improving aviation safety for all users.

ABBREVIATIONS

AC	Advisory Circular
ADC	Animal Damage Control
AGL	Above ground level
APHIS	Animal and Plant Health Inspection Service
ATC	Air traffic control
BPT	Jack Brooks Regional Airport
BTV	Burlington International Airport
COE	U.S. Army Corps of Engineers
COS	Colorado Springs Airport
CFR	Code of Federal Regulations
CTL	Charlotte Douglas International Airport
DEN	Denver International Airport
DFW	Dallas/Fort Worth International Airport
DOD	U.S. Department of Defense
DOT	Department of transportation
EPA	Environmental Protection Agency
ESA	Endangered Species Act
FIFRA	Federal Insecticide, Fungicide, and Rodenticide Act
FWS	U.S. Fish and Wildlife Service
GA	General aviation
GRD	Greenwood County Airport
JFK	John F. Kennedy International Airport
KTN	Ketchikan International Airport
LMT	Klamath Falls Airport
MBTA	Migratory Bird Treaty Act
MCO	Orlando International Airport
MSN	Dane County Regional Airport
MSP	Minneapolis–St. Paul International Airport
ORD	Chicago O’Hare International Airport
PDX	Portland International Airport
RNO	Reno–Tahoe International Airport
SEA	Seattle–Tacoma International Airport
STJ	Rosecrans Memorial Airport
SLC	Salt Lake City International Airport
USDA/WS	U.S. Department of Agriculture, Wildlife Services
WHA	Wildlife Hazard Assessment
WHMP	Wildlife Hazard Management Plan

GLOSSARY

A

Air carrier aircraft. An aircraft that is being operated by an air carrier and is categorized as either a large air carrier aircraft if designed for at least 31 passenger seats or a small air carrier aircraft if designed for more than 9 passenger seats but less than 31 passenger seats, as determined by the aircraft type certificate issued by a competent civil aviation authority (14 CFR 139.5). General aviation aircraft include all other civilian owned and operated aircraft.

Airport operations area (AOA). Any area of an airport used or intended to be used for landing, takeoff, or surface maneuvering of aircraft. An airport operations area includes such paved areas or unpaved areas that are used or intended to be used for the unobstructed movement of aircraft in addition to its associated runway, taxiways, or apron.

Airport. An area of land or other hard surface, excluding water, that is used or intended to be used for the landing and takeoff of aircraft, including any buildings and facilities (14 CFR 139.5).

Airport operator. The operator (private or public) or sponsor of a public-use airport.

Approach or departure airspace. The airspace, within 5 statute miles of an airport, through which aircraft move during landing or takeoff.

B

Barrier fence. Wildlife deterrent fencing that creates either a visual barrier such as construction/silt fencing or physical barrier consistent with FAA guidelines to exclude wildlife from airfields.

Bird hazard. See Wildlife hazard.

Bird strike. See Wildlife strike.

C

Compensatory mortality. Ecological principle by which increased mortality from one factor is offset by reduction in mortality from other factors.

Cover. Vegetation over a ground surface serving as shelter for wildlife that is roosting, resting, nesting, or feeding.

Cover types. A descriptive term characterizing vegetative composition and physical characteristics of a plant community.

D

Detention ponds. Stormwater management ponds that hold stormwater for short periods of time, generally less than 48 hours (compare with retention ponds).

E

Ecological niche. The function or role an organism fills in its environment.

F

Furbearer. Refers to mammals that are generally hunted or trapped for their fur, such as foxes, raccoons, and minks.

G

General aviation aircraft. All civilian aircraft not owned or operated for commercial passenger transport.

General aviation airport. Public use airports that are closed to air carrier operations except in unusual circumstances such as emergencies.

Guild. Groups of different species that generally occupy similar habitats or niches and behave similarly, but do not necessarily follow traditional taxonomic relationships.

H

Hazardous wildlife. Species of wildlife (birds, mammals, reptiles, insects, earth worms), including feral animals and domesticated animals not under control, that are associated with aircraft strike problems, are capable of causing structural damage to airport facilities, or act as attractants to other wildlife that pose a strike hazard

L

Loafing. Wildlife that are “loafing” are simply resting, waiting until it is time to look for food or a place to roost.

M

Mammal strike. See Wildlife strike.

Mesomammal. Intermediate-sized mammals, not necessarily taxonomically related.

Metapopulation. A group of spatially separated populations of the same species that interact at some level. Defined as a population of populations.

Migratory bird. “[A] migratory bird [is] . . . any bird whatever its origin and whether or not raised in captivity, which belongs to a species listed in Section 10.13 [of 50 CFR] or which is a mutation or a hybrid of any such species, including any part, nest, or egg of any such bird, or any product, whether or not manufactured, which consists, or is composed in whole or part, of any such bird, or any part, nest, or egg thereof” (50 CFR 10.12). This list includes almost all native bird species in the United States, with the exception of nonmigratory game birds such as pheasants, turkeys, and grouse. Exotic and feral species such as Graylag Geese, Muscovy Ducks, European Starlings, House (English) Sparrows, and Rock Pigeons (feral pigeons) also are not listed in 50 CFR 10.13 and are therefore not protected by federal law.

Movement area. The runways, taxiways, and other areas of an airport that are used for taxiing or hover taxiing, air taxiing, takeoff, and landing of aircraft, exclusive of loading ramps (apron areas) and aircraft parking areas (14 CFR 139.3).

P

Piscivorous. Organism that eats fish.

Public airport. An airport used or intended to be used for public purposes, which is under the control of a public agency, and of which the area used or intended to be used for landing, taking off, or surface maneuvering of aircraft is publicly owned [49 USC § 47102(16)].

Pyrotechnics. Various combustible projectiles launched from a shotgun, pistol, or other device that produce noise, light, and smoke to frighten wildlife.

R

Raptors. An inclusive term referring to all birds of prey, such as hawks, falcons, eagles, vultures, and owls.

Retention ponds. Stormwater management ponds that hold water for long periods of time, generally more than 48 hours (compare with detention ponds).

Roost. Most commonly the term refers to a perch or general area (such as trees or buildings) used by (roosting) birds to rest and sleep. Roosting birds often collect in large numbers. Pigeons, starlings, and blackbirds are commonly seen roosting birds.

T

Take (wildlife). To pursue, hunt, shoot, wound, kill, trap, capture, or collect or to attempt to pursue, hunt, shoot, wound, kill, trap, capture, or collect any wild animal (50 CFR 10.12).

W

Wildlife. Any wild animal, including without limitation any wild mammal, bird, reptile, fish, amphibian, mollusk,

crustacean, arthropod, coelenterate, or other invertebrate, including any part, product, egg, or offspring thereof (50 CFR 10.12, *Taking, Possession, Transportation, Sale, Purchase, Barter, Exportation, and Importation of Wildlife and Plants*). As used in this manual, wildlife includes feral animals and domestic animals out of the control of their owners (14 CFR 139, Certification of Airports).

Wildlife attractants. Any human-made structure, land-use practice, or human-made or natural geographic feature that can attract or sustain hazardous wildlife within the landing or departure airspace, airport operations area, loading ramps (apron areas), or aircraft parking areas of an airport. These attractants can include but are not limited to architectural features, landscaping, waste disposal sites, wastewater treatment facilities, agricultural or aquaculture activities, surface mining, or wetlands (AC 150/5200-33).

Wildlife hazard. A potential for a damaging aircraft collision with wildlife on or near an airport (14 CFR 139.3).

Wildlife strike. A wildlife strike has occurred when:

1. A pilot reports striking one or more birds or other wildlife;
2. Aircraft maintenance personnel identify aircraft damage as having been caused by a wildlife strike;
3. Personnel on the ground report seeing an aircraft strike one or more birds or other wildlife;
4. Bird or other wildlife remains, whether in whole or in part, are found within 200 feet of a runway centerline, unless another reason for the animal's death is identified; or
5. The animal's presence on the airport had a significant negative effect on a flight.

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APPENDIX A

Federal Aviation Administration, Airports Division, Headquarters, and Regional Offices

U.S. Fish and Wildlife Service's Regional Offices

U.S. Department of Agriculture, Wildlife Services, Headquarters, and State Offices

FEDERAL AVIATION ADMINISTRATION, AIRPORTS DIVISION, HEADQUARTERS, AND REGIONAL OFFICES

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FAA National Headquarters

FAA National Headquarters
Airports Division
800 Independence Avenue, SW
Washington, DC 20591

John Weller, Wildlife Biologist
Amy Anderson, Wildlife Biologist
Tel. (202) 267-3778, Fax (202) 267-5383

FAA New England Regional Headquarters Serving: CT, MA, ME, NH, RI, VT

Federal Aviation Administration
New England Region
12 New England Executive Park
Burlington, MA 01803-5299
Tel. (781) 238-7020, Fax (781) 238-7608

FAA Alaska Region Headquarters Serving: AK

Federal Aviation Administration
Alaskan Region
222 West 7th Avenue #14
Anchorage, AK 99513
Tel. (907) 271-5645, Fax (907) 271-2851

FAA Northwest Mountain Region Headquarters Serving: CO, ID, MT, OR, UT, WA, WY

Federal Aviation Administration
Northwest Mountain Region
1601 Lind Avenue Southwest
Renton, WA 98057
Tel. (425) 227-2001, Fax (425) 227-1600

FAA Central Region Headquarters Serving: KS, IA, MO, NE

Federal Aviation Administration
Central Region
901 Locust Street
Kansas City, MO 64106-2641
Tel. (806) 329-3050, Fax (806) 329-2610/2611

FAA Southern Region Headquarters Serving: AL, FL, GA, KY, MS, NC, PR, SC, TN, VI

Federal Aviation Administration
Southern Region
1701 Columbia Ave.
College Park, GA 30337
Tel. (404) 305-5000, Fax (404) 305-6730

FAA Eastern Region Headquarters Serving: DE, MD, NJ, NY, PA, VA, WV

Federal Aviation Administration
Eastern Region
159-30 Rockaway Boulevard
Jamaica, NY 11434-4848
Tel. (718) 553-3001, Fax (718) 995-5615

FAA Southwest Region Headquarters Serving: AR, LA, NM, OK, TX

Federal Aviation Administration
Southwest Region
2601 Meacham Boulevard
Fort Worth, TX 76137
Tel. (817) 222-5000, Fax (817) 222-5984

FAA Great Lakes Region Headquarters Serving: IL, IN, MI, MN, OH, ND, SD, WI

Federal Aviation Administration
Great Lakes Region
O'Hare Lake Office Center

FAA Western Pacific Region Headquarters Serving: AZ, CA, GU, HI, NV

Federal Aviation Administration
Western-Pacific Region
15000 Aviation Blvd.

Lawndale, CA 90261
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U.S. FISH AND WILDLIFE SERVICE'S REGIONAL OFFICES

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Tel. (503) 872-2715, Fax (503) 231-2019

Region 2 (Serving: AZ, NM, OK, TX)
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Albuquerque, NM 87103
Tel. (505) 248-7882, Fax (505) 248-7885

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Bloomington, MN 55437-1458
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Denver, CO 80225-0486
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Sacramento, CA 95825
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U.S. DEPARTMENT OF AGRICULTURE, WILDLIFE SERVICES, HEADQUARTERS, AND STATE OFFICES

Headquarters
U.S. Department of Agriculture
Animal and Plant Health Inspection Service

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National Wildlife Research Center
USDA/APHIS/WS/NWRC
401 LaPorte Avenue
Fort, Collins, CO 80521-2154

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USDA/APHIS/WS
Eastern Regional Office
920 Main Campus Drive, Suite 200
Raleigh, NC 27606
Tel. (919) 855-7200, Fax (919) 855-7215

**Western Region (Serving: AZ, AK, CA, CO, HI,
GU, ID, KS, MT, NE, NV, NM, ND, OK, OR, SD,
TX, UT, WA, WY)**
USDA/APHIS/WS
Western Regional Office
2150 Center Avenue, Bldg. B, Mail Stop 3W9
Fort Collins, CO 80526-8117
Tel. (970) 494-7443, Fax (970) 494-7455

Alabama

**FAA Southern Region
USFWS Region 4
USDA Eastern Region**

USDA State Office
State Director
School of Forestry and Wildlife
602 Duncan Drive
Auburn Univ.
Auburn, AL 36849
Tel. (334) 844-5670, Fax (334) 844-5321

Alabama Department of Conservation and Natural Resources
Alabama Wildlife and Fresh Water Fisheries Division

Alaska

**FAA Alaska Region
USFWS Region 7
USDA Western Region**

USDA State Office (administered by WA)

State Director
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Olympia, WA 98502
Tel. (360) 753-9884, Fax (360) 753-9466

Alaska Department of Environmental Conservation
Alaska Department of Fish and Game

Arizona

FAA Southwest Region
USFWS Region 2
USDA Western Region

USDA State Office
State Director
8836 North 23rd Ave., Suite B-2
Phoenix, AZ 85021
Tel. (602) 870-2081, Fax (602) 870-2951

Arizona Game and Fish Department
Arizona Natural Resources Division

Arkansas

FAA Southwest Region
USFWS Region 4
USDA Eastern Region

USDA State Office
State Director
1020 Lantrip Road
Sherwood, AR 721201
Tel. (501) 835-2318, Fax (501) 835-2350

Arkansas Department of Environmental Quality
Arkansas Game and Fish Commission

California

FAA Western Pacific Region
USFWS Region 8
USDA Western Region

USDA State Office
State Director
3419-A Arden Way
Sacramento, CA 95825
Tel. (916) 979-2675, Fax (916) 979-2680

California Department of Fish and Game
California Resources Agency

Colorado

FAA Northwest Mountain Region
USFWS Region 6
USDA Western Region

USDA State Office
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12345 W. Alameda Pkwy., Suite 204

Lakewood, CO 80228
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Colorado Department of Natural Resources
Colorado Division of Wildlife

Connecticut

FAA New England Region
USFWS Region 5
USDA Eastern Region

USDA State Office (administered by MA)
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463 West Street
Amherst, MA 01002
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Connecticut Department of Environmental Protection
Connecticut Division of Wildlife
Connecticut Fisheries Division

Delaware

FAA Eastern Region
USFWS Region 5
USDA Eastern Region

USDA State Office (administered by MD)
State Director
1568 Whitehall Road
Annapolis, MD 21401
Tel. (410) 349-8055, Fax (410) 349-8258

Delaware Department of Natural Resources
and Environmental Control
Delaware Division of Fish and Wildlife

District of Columbia

FAA Eastern Region
USFWS Region 5
USDA Eastern Region

USDA State Office (administered by MD)
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District of Columbia Fisheries and Wildlife Division

Florida

FAA Southern Region
USFWS Region 4
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USDA State Office
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Florida Fish and Wildlife Commission

Georgia

FAA Southern Region
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Georgia Department of Natural Resources
Georgia Wildlife Resources

Guam

FAA Western Pacific Region
USFWS Region 1
USDA Western Region

USDA State Office (administered by HI)
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Hawaii

FAA Western Pacific Region
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USDA State Office
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Hawaii Department of Land and Natural Resources
Hawaii Division of Aquatic Resources
Hawaii Division of Forestry and Wildlife

Idaho

FAA Northwest Mountain Region
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Illinois

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Illinois Department of Natural Resources
Illinois Environmental Protection Agency

Indiana

FAA Great Lakes Region
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 W. Lafayette, IN 47907
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Indiana Department of Natural Resources
Indiana Division of Fish and Wildlife

Iowa

FAA Central Region
USFWS Region 3
USDA Eastern Region

USDA State Office (administered by MO)
 State Director
 1714 Commerce Court, Suite C
 Columbia, MO 65202
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Iowa Department of Natural Resources

Kansas

FAA Central Region
USFWS Region 6
USDA Eastern Region

USDA State Office
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 Manhattan, KS 66502
 Tel. (785) 537-6855, Fax (785) 537-6862

Kansas Department of Health and Environment
Kansas Department of Wildlife and Parks

Kentucky

FAA Southern Region
USFWS Region 4
USDA Eastern Region

USDA State Office (administered by TN)

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Madison, TN 37115
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Kentucky Department for Environmental Protection
Kentucky Department of Fish and Wildlife Resources

Louisiana

FAA Southwest Region
USFWS Region 4
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USDA State Office

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Port Allen, LA 70767
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Louisiana Department of Environmental Quality
Louisiana Department of Natural Resources
Louisiana Department of Wildlife and Fisheries

Maine

FAA New England Region
USFWS Region 5
USDA Eastern Region

USDA State Office

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Augusta, ME 04330
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Maine Department of Conservation
Maine Department of Environmental Protection
Maine Department of Inland Fisheries and Wildlife

Maryland

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Massachusetts

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Massachusetts Department of Conservation and Recreation
Massachusetts Department of Environmental Protection
Massachusetts Department of Fish and Game

Michigan

FAA Great Lakes Region
USFWS Region 3
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Okemos, MI 48864
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Michigan Department of Environmental Quality
Michigan Department of Natural Resources

Minnesota

FAA Great Lakes Region
USFWS Region 3
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USDA State Office

State Director
644 Bayfield Street, Suite 215
St. Paul, MN 55107
Tel. (651) 224-6027, Fax (651) 224-4271

Minnesota Department of Natural Resources
Minnesota Division of Fish and Wildlife
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Mississippi

FAA Southern Region
USFWS Region 4
USDA Eastern Region

USDA State Office

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Mississippi Department of Environmental Quality
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Missouri

FAA Central Region
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Missouri Department of Conservation
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Montana

FAA Northwest Mountain Region
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Montana Department of Environmental Quality
Montana Fish, Wildlife and Parks
Montana Department of Natural Resources and Conservation

Nebraska

FAA Central Region
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Lincoln, NE 68516
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Nebraska Department of Environmental Quality
Nebraska Game and Parks Commission
Nebraska Department of Natural Resources

Nevada

FAA Western Pacific Region
USFWS Region 8
USDA Western Region

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Nevada Department of Conservation and Natural Resources
Nevada Division of Environmental Protection
Nevada Division of Wildlife

New Hampshire

FAA New England Region
USFWS Region 5
USDA Eastern Region

USDA State Office

State Director
59 Chenell Drive, Suite 7
Concord, NH 03301
Tel. (603) 223-6832, Fax (603) 229-1951

New Hampshire Department of Environmental Services
New Hampshire Department of Resources and Economic Development
New Hampshire Fish and Game Department

New Jersey

FAA Eastern Region
USFWS Region 5
USDA Eastern Region

USDA State Office

State Director
140-C Locust Grove Road
Pittstown, NJ 08867
Tel. (908) 735-5654 Ext. 7, Fax (908) 735-0821

New Jersey Department of Environmental Protection
New Jersey Division of Fish, Game and Wildlife

New York

FAA Eastern Region
USFWS Region 5
USDA Eastern Region

USDA State Office

State Director
1930 Route 9
Castleton, NY 12033
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New York Department of Environmental Conservation
New York Division of Fish, Wildlife, and Marine Resources

New Mexico

FAA Southwest Region
USFWS Region 2
USDA Western Region

USDA State Office

State Director
8441 Washington NE
Albuquerque, NM 87113
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New Mexico Energy, Minerals, and Natural Resources Department
New Mexico Environment Department

North Carolina

FAA Southern Region
USFWS Region 4
USDA Eastern Region

USDA State Office

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6213-E. Angus Drive
Raleigh, NC 27617
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North Carolina Department of Environment and Natural Resources

North Carolina Division of Marine Fisheries

North Carolina Wildlife Resources Commission

North Dakota**FAA Great Lakes Region****USFWS Region 6****USDA Western Region****USDA State Office**

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2110 Miriam Circle, Suite A
Bismark, ND 58501-2502
Tel. (701) 250-4405, Fax (701) 250-4408

North Dakota Game and Fish Department

Ohio**FAA Great Lakes Region****USFWS Region 3****USDA Eastern Region****USDA State Office**

State Director
6929 Americana Parkway
Reynoldsburg, OH 43068
Tel. (614) 861-6087, Fax (614) 861-9018

Ohio Department of Natural Resources

Ohio Division of Natural Areas and Preserves

Ohio Division of Wildlife

Oklahoma**FAA Southwest Region****USFWS Region 2****USDA Western Region****USDA State Office**

State Director
2800 N. Lincoln Boulevard
Oklahoma City, OK 73105
Tel. (405) 521-4039, Fax (405) 525-5951

Oklahoma Department of Environmental Quality

Oklahoma Department of Wildlife Conservation

Oregon**FAA Northwest Mountain Region****USFWS Region 1****USDA Western Region****USDA State Office**

State Director
6135 NE 80th, Suite A-8
Portland, OR 97218
Tel. (503) 326-2346, Fax (503) 326-2367

Oregon Department of Environmental Quality

Oregon Department of Fish and Wildlife

Pacific Islands**FAA Western Pacific Region****USFWS Region 1****USDA Western Region****USDA State Office (administered by HI)**

State Director
3375 Koapaka Street, Suite H-420
Honolulu, HI 96819
Tel. (808) 861-8576, Fax (808) 861-8570

Natural Resources Conservation Service Pacific Islands Area

Pennsylvania**FAA Eastern Region****USFWS Region 5****USDA Eastern Region****USDA State Office**

State Director
P.O. Box 60827
Summerdale, PA 17106
Tel. (717) 236-9451, Fax (717) 236-9454

Pennsylvania Department of Conservation and Natural Resources

Pennsylvania Department of Environmental Protection

Pennsylvania Fish and Boat Commission

Pennsylvania Game Commission

Puerto Rico**FAA Southern Region****USFWS Region 4****USDA Eastern Region****USDA State Office (administered by AL)**

State Director
School of Forestry and Wildlife
602 Duncan Drive
Auburn Univ.
Auburn, AL 36849
Tel. (334) 844-5670, Fax (334) 844-5321

Puerto Rico Department of Natural and Environmental Resources

Rhode Island**FAA New England Region****USFWS Region 5****USDA Eastern Region**

USDA State Office (administered by MA)

State Director
463 West Street
Amherst, MA 01002
Tel. (413) 253-2403, Fax (413) 253-7577

Rhode Island Bureau of Environmental Protection
Rhode Island Division of Fish and Wildlife

South Carolina

FAA Southern Region
USFWS Region 4
USDA Eastern Region

USDA State Office

State Director
400 Northeast Drive, Suite L
Columbia, SC 29203
Tel. (803) 786-9455, Fax (803) 786-9472

South Carolina Department of Health and Environmental Control
South Carolina Department of Natural Resources

South Dakota

FAA Great Lakes Region
USFWS Region 6
USDA Western Region

USDA State Office

State Director
420 S. Garfield Avenue, Suite 300
Pierre, SD 57501
Tel. (605) 224-8692, Fax (605) 945-2677

South Dakota Department of Environment and Natural Resources
South Dakota Department of Game, Fish and Parks

Tennessee

FAA Southern Region
USFWS Region 4
USDA Eastern Region

USDA State Office

State Director
537 Myatt Drive
Madison, TN 37115
Tel. (615) 736-5506, Fax (615) 736-2768

Tennessee Department of Environment and Conservation
Tennessee Wildlife Resources Agency

Texas

FAA Southwest Region
USFWS Region 2
USDA Western Region

USDA State Office

State Director
P.O. Box 690170
San Antonio, TX 78269
Tel. (210) 472-5451, Fax (210) 561-3846

Texas Commission on Environmental Quality
Texas Parks and Wildlife
Texas Wildlife Damage Management Service

Utah

FAA Northwest Mountain Region
USFWS Region 6
USDA Western Region

USDA State Office

State Director
P.O. Box 26976
Salt Lake City, UT 84126
Tel. (801) 975-3315, Fax (801) 975-3320

Utah Department of Environmental Quality
Utah Department of Natural Resources
Utah Division of Wildlife Resources

Vermont

FAA New England Region
USFWS Region 5
USDA Eastern Region

USDA State Office

State Director
617 Comstock Road, Suite 9
Berlin, VT 05602
Tel. (802) 223-8690, Fax (802) 229-1435

Vermont Agency of Natural Resources
Vermont Department of Fish & Wildlife
Vermont Department of Environmental Conservation

Virginia

FAA Southern Region
USFWS Region 5
USDA Eastern Region

USDA State Office

State Director
Virginia Wildlife Services
P.O. Box 130
Moseley, VA 23120
Tel. (804) 739-7739; Fax (804) 739-7738

Virginia Department of Conservation and Recreation
Virginia Department of Environmental Quality
Virginia Department of Game and Inland Fisheries
Virginia Marine Resources Commission

Virgin Islands

FAA Southern Region
USFWS Region 4
USDA Eastern Region

USDA State Office (administered by AL)

State Director
School of Forestry and Wildlife
602 Duncan Drive
Auburn Univ.
Auburn, AL 36849
Tel. (334) 844-5670, Fax (334) 844-5321

U.S. Virgin Islands Department of Planning and Natural Resources

Washington

FAA Northwest Mountain Region
USFWS Region 1
USDA Western Region

USDA State Office
State Director
720 O'Leary Street NW
Olympia, WA 98502
Tel. (360) 753-9884, Fax (360) 753-9466

Washington State Conservation Commission
Washington Department of Fish and Wildlife

West Virginia

FAA Eastern Region
USFWS Region 5
USDA Eastern Region

USDA State Office
State Director
730 Yokum Street

Elkins, WV 26241
Tel. (304) 636-1785, Fax (304) 636-5397

West Virginia Division of Environmental Protection
West Virginia Division of Natural Resources

Wisconsin

FAA Great Lakes Region
USFWS Region 3
USDA Eastern Region

USDA State Office
State Director
732 Lois Drive
Sun Prairie, WI 53590
Tel. (608) 837-2727, Fax (608) 837-6754

Wisconsin Department of Natural Resources

Wyoming

FAA Northwest Mountain Region
USFWS Region 6
USDA Western Region

USDA State Office
State Director
P.O. Box 59
Casper, WY 82602
Tel. (307) 261-5336, Fax (307) 261-5996

Wyoming Department of Environmental Quality
Wyoming Game and Fish Department

APPENDIX B

USDA/WS Form 37

Depredation Permit, Depredation Permit Instructions, and USFWS Permit Contact Information

U.S. DEPARTMENT OF AGRICULTURE
ANIMAL AND PLANT HEALTH INSPECTION SERVICE
WILDLIFE SERVICES

☐ **RENEWAL**

Permit No:

☐ Without Change

1. Name, Address, and Telephone Number Telephone ☐ Home ☐ Work Fax/Email:		2. Location of Damage		
		3. County	4. State	
5. RESOURCE/DAMAGE ESTIMATE				
A. Resources Damaged		B. Description of Damage		
6. MIGRATORY BIRD SPECIES		7. PERMIT RECOMMENDATION		
Depredating Species	Number Involved	Take Recommendation	Number Recommended	Methods
1.		☐ Yes ☐ No		
2.		☐ Yes ☐ No		
3.		☐ Yes ☐ No		
4.		☐ Yes ☐ No		
8a. PREVIOUS ACTIONS TO ADDRESS PROBLEM AND RESULTS OF THOSE ACTIONS:				
8b. COMMENTS:				
9. RECOMMENDED ACTIONS				
Action:				
☐ Harassment ☐ Habitat Alteration ☐ Husbandry ☐ Exclusion ☐ Lethal trapping ☐ Chemical repellent ☐ Capture and relocation ☐ Egg/nest destruction ☐ Shooting ☐ Other:				
10A. WS Investigator Name and Address: <i>(Print)</i>		10B. WS Investigator Signature		
Telephone Number: Email:		Date of Investigation: (Use this date as MIS entry date)		

Privacy Act Notice

Title 5, United States Code, Section 552a(e)(3) requires that each agency that maintains a system of records provide each individual from whom the agency solicits information with the following information.

Authority for Requesting Information

Title 7, United States Code, Section 426-426c, and Title 16 United States Code, Section 667, authorizes officers, agents, and employees of the USDA, APHIS, Wildlife Services to conduct a program of wildlife services and to enter into agreements with States, local jurisdictions, individuals, and public and private agencies, organizations, and institutions for the purpose of conducting such services.

Nature of Your Disclosure of Information

Disclosure of information solicited by USDA, APHIS, Wildlife Services is voluntary.

Principle Purpose for Which the Information is Solicited

Information is solicited from you for the purpose of executing and implementing agreements for control of wildlife damage.

Routine Uses Which May be Made of the Information

The routine uses which may be made of the information are:

Routine use 1 permits disclosure to cooperative State government officials, employees, or contractors, as necessary to carry out the program; and other parties engaged to assist in administering the program. Such contractors and other parties will be bound by the nondisclosure provisions of the Privacy Act. This routine use assists the agency in carrying out the program, and thus is compatible with the purpose for which the records are created and maintained;

Routine use 2 permits disclosure to the appropriate agency, whether Federal, State, local, or foreign, charged with responsibility of investigating or prosecuting a violation of law or of enforcing, implementing, or complying with a statute, rule, regulation, or order issued pursuant thereto, of any record within this system when information available indicates a violation or potential violation of law, whether civil, criminal, or regulatory in nature, and either arising by general statute or particular program statute, or by rule, regulation, or court order issued pursuant thereto;

Routine use 3 permits disclosure to the Department of Justice when the agency, or any component thereof, or any employee of the agency in his or her official capacity, or any employee of the agency in his or her individual capacity where the Department of Justice has agreed to represent the employee, or the United States, in litigation, where the agency determines that litigation is likely to affect the agency or any of its components, is a party to litigation or has an interest in such litigation, and the use of such records by the Department of Justice is deemed by the agency to be relevant and necessary to the litigation; provided, however, that in each case, the agency determines that disclosure of the records to the Department of Justice is a use of the information contained in the records that is compatible with the purpose for which the records were collected;

Routine use 4 permits disclosure for use in a proceeding before a court or adjudicative body before which the agency is authorized to appear, when the agency, or any component thereof, or any employee of the agency in his or her official capacity, or any employee of the agency in his or her individual capacity where the agency has agreed to represent the employee, or the United States, where the agency determines that litigation is likely to affect the agency or any of its components, is a party to litigation or has an interest in such litigation, and the agency determines that use of such records is relevant and necessary to the litigation; provided, however, that in each case, the agency determines that disclosure of the records to the court is a use of the information contained in the records that is compatible with the purpose for which the records were collected;

Routine use 5 permits disclosure to appropriate agencies, entities, and persons when the agency suspects or has confirmed that the security or confidentiality of information in the system of records has been compromised; the agency has determined that as a result of the suspected or confirmed compromise there is a risk of harm to economic or property interests, a risk of identity theft or fraud, or a risk of harm to the security or integrity of this system or other systems or programs (whether maintained by the agency or another agency or entity) that rely upon the compromised information; and the disclosure made to such agencies, entities, and persons is reasonably necessary to assist in connection with the agency's efforts to respond to the suspected or confirmed compromise and prevent, minimize, or remedy such harm.

Routine use 6 permits disclosure to USDA employees or contractors, partner agency employees or contractors, or private industry employed to identify patterns, trends or anomalies indicative of fraud, waste, or abuse.

Routine use 7 permits disclosure to the National Archives and Records Administration or to the General Services Administration for records management inspections conducted under 44 U.S.C. §§ 2904 and 2906.

Effects of Failure to Furnish Information

Failure to provide the solicited information will not subject you to penalties or adverse consequences.



Department of the Interior
U.S. Fish and Wildlife Service
Federal Fish and Wildlife Permit Application Form

OMB Control No. 1018 - 0022
Expires 02/28/2014

Return to: U.S. Fish and Wildlife Service (USFWS)

Type of Activity: Migratory Bird Depredation Permit

Complete Sections A or B, and C, D, and E of this application. U.S. address may be required in Section C, see instructions for details. **See attached instruction pages for information on how to make your application complete and help avoid unnecessary delays.**

A. Complete if applying as an individual			
1.a. Last name		1.b. First name	1.c. Middle name or initial
2. Date of birth (mm/dd/yyyy)		3. Social Security No.	1.d. Suffix
4. Occupation		5. Affiliation/ Doing business as (see instructions)	
6.a. Telephone number	6.b. Alternate telephone number	6.c. Fax number	6.d. E-mail address

B. Complete if applying on behalf of a business, corporation, public agency, tribe, or institution			
1.a. Name of business, agency, tribe, or institution		1.b. Doing business as (dba)	
2. Tax identification no.	3. Description of business, agency, or institution		
4.a. Principal officer Last name	4.b. Principal officer First name	4.c. Principal officer Middle name/ initial	4.d. Suffix
5. Principal officer title		6. Primary contact	
7.a. Business telephone number	7.b. Alternate telephone number	7.c. Business fax number	7.d. Business e-mail address

C. All applicants complete address information					
1.a. Physical address (Street address; Apartment #, Suite #, or Room #; no P.O. Boxes)					
1.b. City	1.c. State	1.d. Zip code/Postal code:	1.e. County/Province	1.f. Country	
2.a. Mailing Address (include if different than physical address; include name of contact person if applicable)					
2.b. City	2.c. State	2.d. Zip code/Postal code:	2.e. County/Province	2.f. Country	

D. All applicants MUST complete	
1.	Attach check or money order payable to the U.S. FISH AND WILDLIFE SERVICE in the amount of \$100.00 if you are applying for a new permit or \$50.00 if you are requesting a substantive amendment to your existing permit. If you are a homeowner requesting a permit for damage to your personal residence or property, attach \$50.00. Federal, tribal, State, and local government agencies, and those acting on behalf of such agencies, are exempt from the processing fee – <u>attach documentation of fee exempt status as outlined in instructions.</u> (50 CFR 13.11(d))
2.	Do you currently have or have you ever had any Federal Fish and Wildlife permits? Yes ~ If yes, list the number of the most current permit you have held or that you are applying to renew/re-issue: No ~
3.	Certification: I hereby certify that I have read and am familiar with the regulations contained in <i>Title 50, Part 13 of the Code of Federal Regulations</i> and the other <i>applicable parts in subchapter B of Chapter I of Title 50</i> , and I certify that the information submitted in this application for a permit is complete and accurate to the best of my knowledge and belief. I understand that any false statement herein may subject me to the criminal penalties of 18 U.S.C. 1001.
Signature (in blue ink) of applicant/person responsible for permit (No photocopied or stamped signatures)	
Date of signature (mm/dd/yyyy)	

Please continue to next page

E. MIGRATORY BIRD DEPREDAATION PERMIT
(Migratory Bird Treaty Act, 50 CFR 21.41)

A Federal Migratory Bird Depredation Permit is required to capture or kill migratory birds for depredation control purposes. The permit authorizes certain management and control activities necessary to provide for human health and safety, protect personal property, or allow resolution of other injury to people or property. No permit is required merely to scare or herd depredating migratory birds other than endangered or threatened species and bald or golden eagles. You should apply for a depredation permit only after non-lethal management proves unsuccessful. If a permit is issued, you will be expected to continue to integrate nonlethal techniques when implementing any lethal measures. You must be at least 18 years of age to apply.

Protected Species: The species listed in the Code of Federal Regulations at 50 CFR 10.13 are protected under the Migratory Bird Treaty Act. A list of species in the U.S. and their status under the MBTA is available at the following website: <http://www.fws.gov/migratorybirds/issues/nonnative/MBTA-protected&NonprotectedSpecies.htm>.

Resident Canada goose nests & eggs: If you are only destroying or adding resident Canada goose eggs and your state is one that accepts Federal registration, you may register for free on-line at <https://epermits.fws.gov/eRCGR> in lieu of obtaining a depredation permit.

Note: Your application for a depredation permit must include a recommendation from the U.S. Department of Agriculture, Animal and Plant Health Inspection Service, Wildlife Services, for addressing your depredation problem. You may contact Wildlife Services at (866) 487-3297. If Wildlife Services recommends that a permit be issued to capture or kill birds, they will complete a Wildlife Services Permit Review Form (Form 37). This form and a copy of any required State permits must accompany your application. (This form is not required for resident Canada goose egg adding/destruction/OvoControl™G.)

Please provide the following information numbered according to the questions below on a separate sheet of paper. You should be as specific as possible in your responses. You should submit your application at least 60 days prior to the date that you need your permit (50 CFR 13.11(c)).

1. List the species of migratory birds causing the depredation problem and estimate the number of each involved.
2. Provide the exact location of the property or properties where the control activity would be conducted (State, county, and physical address of the specific site).
3. Description of damage.
 - (a) Describe the specific migratory bird damage or injury you are experiencing.
 - (b) How long has it been occurring (e.g., the number of years)?
 - (c) What times or seasons of the year does it occur?
 - (d) Describe any human health and safety hazards involved.
 - (e) Provide details such as types of crops destroyed, human injuries sustained, property damage incurred, and health and safety hazards created.
4. Describe the extent of the damage and estimate the economic loss suffered as a result, such as percentage of acres of crop and dollar loss, cost to replace damaged property, or cost of injuries.
5. Describe the nonlethal measures you have taken to control or eliminate the problem, including how long (e.g., a week, month, year(s)) and how often they have been conducted. List the techniques you have tried, such as harassment (e.g., horns, pyrotechnics, propane cannons), habitat management (e.g., vegetative barriers, longer grass management, fencing), cultural practices (e.g., crop selection and placement, management of pets and feeding schedules), or no feeding policies.
6. Proposed actions.
 - (a) What actions are you proposing to take to alleviate the problem (e.g., kill, eliminate nesting, trap and relocate)?
 - (b) Describe the method you propose (e.g., shoot; addle, oil, destroy eggs; trap and relocate; trap and donate birds to a food processing center).
 - (c) If you propose to trap birds, describe the method that will be used and your (or your agent's) experience with the method.
7. What long-term measures do you plan to take to eliminate the problem?

8. If you are applying on behalf of an airport for a permit to control birds in flight zones, indicate whether you are operating under an approved Wildlife Hazard Management Plan.
 9. Anyone who will be acting as your agent or assisting you with the activities authorized by your permit must be authorized as a subpermittee under your permit. As the primary permittee, you will be legally responsible for ensuring that your subpermittees comply with the terms of your permit. List the name of anyone who will be directly involved in doing the work to resolve your problems. Include any commercial company that may be contracted to conduct the work.
 10. You must retain records relating to the activities conducted under your permit for at least 5 years from the date of expiration of your permit. Is the physical address you provided in Section C on page 1 of this application the address where your records will be kept?
-

Yes ____ No ____ If "no," provide the physical address:

11. **Any permit issued as a result of this application is not valid unless you also have any required State or tribal permits or approvals associated with the activity.** Have you obtained all required State or tribal permits or approvals to conduct this activity?

____ Yes If "yes," attach a copy of the approval(s). ____ Have applied (**Send copy when issued**) ____ None required

12. Attach a copy of the completed Wildlife Services Permit Review Form (Form 37) prepared by USDA, APHIS, Wildlife Services providing their recommendation regarding your depredation problem.

PERMIT APPLICATION FORM INSTRUCTIONS

The following instructions pertain to an application for a U.S. Fish and Wildlife Service or CITES permit. The General Permit Procedures in 50 CFR 13 address the permitting process. For simplicity, all licenses, permits, registrations, and certificates are referred to as a permit.

GENERAL INSTRUCTIONS:

- Complete all blocks/lines/questions in Sections A or B, and in C, D, and E.
- **An incomplete application may cause delays in processing or may be returned to the applicant. Be sure you are filling in the appropriate application form for the proposed activity.**
- Print clearly or type in the information. Illegible applications may cause delays.
- Sign the application in blue ink. Faxes or copies of the original signature will not be accepted.
- Mail the original application to the address at the top of page one of the application or if applicable on the attached address list.
- **Keep a copy of your completed application.**
- **Please plan ahead. Allow at least 60 days for your application to be processed. Some applications may take longer than 90 days to process. (50 CFR 13.11)**
- Applications are processed in the order they are received.
- Additional forms and instructions are available from <http://permits.fws.gov>.

COMPLETE EITHER SECTION A OR SECTION B:

Section A. Complete if applying as an individual:

- Enter the complete name of the responsible individual who will be the permittee if a permit is issued. Enter personal information that identifies the applicant. ***Fax and e-mail are not required if not available.***
- If you are applying on behalf of a client, the personal information must pertain to the client, and a document evidencing power of attorney must be included with the application.
- **Affiliation/ Doing business as (dba):** business, agency, organizational, or institutional affiliation *directly* related to the activity requested in the application (e.g., a taxidermist is an individual whose business can *directly* relate to the requested activity). The Division of Management Authority (DMA) will **not** accept *doing business as* affiliations for individuals.

Section B. Complete if applying as a business, corporation, public agency, tribe, or institution:

- Enter the complete name of the business, agency, tribe, or institution that will be the permittee if a permit is issued. Give a brief description of the type of business the applicant is engaged in. Provide contact phone number(s) of the business.
- **Principal Officer** is the person in charge of the listed business, corporation, public agency, tribe, or institution. The principal officer is the person responsible for the application and any permitted activities. Often the principal officer is a Director or President. **Primary Contact** is the person at the business, corporation, public agency, tribe, or institution who will be available to answer questions about the application or permitted activities. Often this is the preparer of the application.

ALL APPLICANTS COMPLETE SECTION C:

- For all applications submitted to the Division of Management Authority (DMA) a physical U.S. address is **required**. Province and Country blocks are provided for those USFWS programs which use foreign addresses and are not required by DMA.
- **Mailing address** is address where communications from USFWS should be mailed if different than applicant's physical address.

ALL APPLICANTS COMPLETE SECTION D: Section D.1 Application processing fee:

- An application processing fee is required at the time of application; unless exempted under 50 CFR 13.11(d)(3). The application processing fee is assessed to partially cover the cost of processing a request. **The fee does not guarantee the issuance of a permit. Fees will not be refunded for applications that are approved, abandoned, or denied.** We may return fees for withdrawn applications prior to any significant processing occurring.
- **Documentation of fee exempt status is not required for Federal, tribal, State, or local government agencies; but must be supplied by those applicants acting on behalf of such agencies.** Those applicants acting on behalf of such agencies must submit a letter on agency letterhead and signed by the head of the unit of government for which the applicant is acting on behalf, confirming that the applicant will be carrying out the permitted activity for the agency.

Section D.2 Federal Fish and Wildlife permits:

- List the number(s) of your most current FWS or CITES permit or the number of the most recent permit if none are currently valid. If applying for re-issuance of a CITES permit, the original permit must be returned with this application.

Section D.3 CERTIFICATION:

- **The individual identified in Section A, the principal officer named in Section B, or person with a valid power of attorney (documentation must be included in the application) must sign and date the application in blue ink.** This signature binds the applicant to the statement of certification. This means that you certify that you have read and understand

ALL APPLICANTS COMPLETE SECTION E.

Please continue to next page

APPLICATION FOR A FEDERAL FISH AND WILDLIFE PERMIT
Paperwork Reduction Act, Privacy Act, and Freedom of Information Act – Notices

In accordance with the Paperwork Reduction Act of 1995 (44 U.S.C. 3501, *et seq.*) and the Privacy Act of 1974 (5 U.S.C. 552a), please be advised:

1. The gathering of information on fish and wildlife is authorized by:
 (Authorizing statutes can be found at: <http://www.gpoaccess.gov/cfr/index.html> and <http://www.fws.gov/permits/ltr/ltr.html>.)
 - a. Bald and Golden Eagle Protection Act (16 U.S.C. 668), 50 CFR 22;
 - b. Endangered Species Act of 1973 (16 U.S.C. 1531-1544), 50CFR 17;
 - c. Migratory Bird Treaty Act (16 U.S.C. 703-712), 50 CFR 21;
 - d. Marine Mammal Protection Act of 1972 (16 U.S.C. 1361, *et. seq.*), 50 CFR 18;
 - e. Wild Bird Conservation Act (16 U.S.C. 4901-4916), 50 CFR 15;
 - f. Lacey Act: Injurious Wildlife (18 U.S.C. 42), 50 CFR 16;
 - g. Convention on International Trade in Endangered Species of Wild Fauna and Flora (TIAS 8249), <http://www.cites.org> , 50 CFR 23;
 - h. General Provisions, 50 CFR 10;
 - i. General Permit Procedures, 50 CFR 13; and
 - j. Wildlife Provisions (Import/export/transport), 50 CFR 14.
2. Information requested in this form is purely voluntary. However, submission of requested information is required in order to process applications for permits authorized under the above laws. Failure to provide all requested information may be sufficient cause for the U.S. Fish and Wildlife Service to deny the request. We may not conduct or sponsor and you are not required to respond to a collection of information unless it displays a currently valid OMB control number.
3. Certain applications for permits authorized under the Endangered Species Act of 1973 (16 U.S.C. 1539) and the Marine Mammal Protection Act of 1972 (16 U.S.C. 1374) will be published in the **Federal Register** as required by the two laws.
4. Disclosures outside the Department of the Interior may be made without the consent of an individual under the routine uses listed below, if the disclosure is compatible with the purposes for which the record was collected. (Ref. 68 FR 52611, September 4, 2003)
 - a. Routine disclosure to subject matter experts, and Federal, tribal, State, local, and foreign agencies, for the purpose of obtaining advice relevant to making a decision on an application for a permit or when necessary to accomplish a FWS function related to this system of records.
 - b. Routine disclosure to the public as a result of publishing **Federal Register** notices announcing the receipt of permit applications for public comment or notice of the decision on a permit application.
 - c. Routine disclosure to Federal, tribal, State, local, or foreign wildlife and plant agencies for the exchange of information on permits granted or denied to assure compliance with all applicable permitting requirements.
 - d. Routine disclosure to Captive-bred Wildlife registrants under the Endangered Species Act for the exchange of authorized species, and to share information on the captive breeding of these species.
 - e. Routine disclosure to Federal, tribal, State, and local authorities who need to know who is permitted to receive and rehabilitate sick, orphaned, and injured birds under the Migratory Bird Treaty Act and the Bald and Golden Eagle Protection Act; federally permitted rehabilitators; individuals seeking a permitted rehabilitator with whom to place a bird in need of care; and licensed veterinarians who receive, treat, or diagnose sick, orphaned, and injured birds.
 - f. Routine disclosure to the Department of Justice, or a court, adjudicative, or other administrative body or to a party in litigation before a court or adjudicative or administrative body, under certain circumstances.
 - g. Routine disclosure to the appropriate Federal, tribal, State, local, or foreign governmental agency responsible for investigating, prosecuting, enforcing, or implementing statutes, rules, or licenses, when we become aware of a violation or potential violation of such statutes, rules, or licenses, or when we need to monitor activities associated with a permit or regulated use.
 - h. Routine disclosure to a congressional office in response to an inquiry to the office by the individual to whom the record pertains.
 - i. Routine disclosure to the General Accounting Office or Congress when the information is required for the evaluation of the permit programs.
 - j. Routine disclosure to provide addresses obtained from the Internal Revenue Service to debt collection agencies for purposes of locating a debtor to collect or compromise a Federal claim against the debtor or to consumer reporting agencies to prepare a commercial credit report for use by the FWS.

5. For individuals, personal information such as home address and telephone number, financial data, and personal identifiers (social security number, birth date, etc.) will be removed prior to any release of the application.
6. The public reporting burden on the applicant for information collection varies depending on the activity for which a permit is requested. The relevant burden for a Migratory Bird Depredation permit application varies from 1.5 hours for individuals to 3 hours for businesses. The burden for recordkeeping varies from 15 minutes for individuals to 30 minutes for businesses. This burden estimate includes time for reviewing instructions, gathering and maintaining data and completing and reviewing the form. You may direct comments regarding the burden estimate or any other aspect of the form to the Service Information Clearance Officer, U.S. Fish and Wildlife Service, Mail Stop 222, Arlington Square, U.S. Department of the Interior, 1849 C Street, NW, Washington D.C. 20240.

Freedom of Information Act – Notice

For organizations, businesses, or individuals operating as a business (i.e., permittees not covered by the Privacy Act), we request that you identify any information that should be considered privileged and confidential business information to allow the Service to meet its responsibilities under FOIA. Confidential business information must be clearly marked "Business Confidential" at the top of the letter or page and each succeeding page and must be accompanied by a non-confidential summary of the confidential information. The non-confidential summary and remaining documents may be made available to the public under FOIA [43 CFR 2.13(c)(4), 43 CFR 2.15(d)(1)(i)].



U.S. Fish & Wildlife Service

Migratory Bird Regional Permit Offices

FWS REGION	AREA OF RESPONSIBILITY	MAILING ADDRESS	CONTACT INFORMATION
Region 1	Hawaii, Idaho, Oregon, Washington	911 N.E. 11th Avenue Portland, OR 97232-4181	Tel. (503) 872-2715 Fax (503) 231-2019 Email permitsR1MB@fws.gov
Region 2	Arizona, New Mexico, Oklahoma, Texas	P.O. Box 709 Albuquerque, NM 87103	Tel. (505) 248-7882 Fax (505) 248-7885 Email permitsR2MB@fws.gov
Region 3	Iowa, Illinois, Indiana, Minnesota, Missouri, Michigan, Ohio, Wisconsin	5600 America Blvd. West Suite 990 Bloomington, MN 55437-1458 (Effective 5/31/2011)	Tel. (612) 713-5436 Fax (612) 713-5393 Email permitsR3MB@fws.gov
Region 4	Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, South Carolina, Tennessee, Virgin Islands, Puerto Rico	P.O. Box 49208 Atlanta, GA 30359	Tel. (404) 679-7070 Fax (404) 679-4180 Email permitsR4MB@fws.gov
Region 5	Connecticut, District of Columbia, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Virginia, Vermont, West Virginia	P.O. Box 779 Hadley, MA 01035-0779	Tel. (413) 253-8643 Fax (413) 253-8424 Email permitsR5MB@fws.gov
Region 6	Colorado, Kansas, Montana, North Dakota, Nebraska, South Dakota, Utah, Wyoming	P.O. Box 25486 DFC(60154) Denver, CO 80225-0486	Tel. (303) 236-8171 Fax (303) 236-8017 Email permitsR6MB@fws.gov
Region 7	Alaska	1011 E. Tudor Road (MS-201) Anchorage, AK 99503	Tel. (907) 786-3693 Fax (907) 786-3641 Email permitsR7MB@fws.gov
Region 8	California, Nevada	2800 Cottage Way Sacramento, CA 95825	Tel. (916) 978-6183 Fax (916) 414-6486 Email permitsR8MB@fws.gov

APPENDIX C

Vertebrate Control Products Currently Registered or Approved for Use by USDA APHIS Wildlife Services

Vertebrate control products currently registered or approved for use by USDA APHIS				
Taxa	APHIS Products	Mode of Action	Species	Uses Unique to APHIS
Rodents	Zinc phosphide (3 products)	Lethal	Voles, mice, rats, hares, woodchucks, ground squirrels, muskrats, nutria, prairie dogs	Some
	Strychnine (4 products)	Lethal	Pocket Gophers	No
	Gas cartridge (1 product)	Lethal	Prairie dogs, ground squirrels, woodchucks, marmots	No
	Diphacinone (1 product)	Lethal	Invasive rodents on islands	Yes
	Brodifacoum (2 products)	Lethal	Invasive rodents on islands	Yes
Canine Predators	Large gas cartridge (1 product)	Lethal	Coyotes, Red Foxes, Striped Skunks	Yes
	M-44 Cyanide capsules (2 products)	Lethal	Coyotes, Red Foxes, Gray Foxes, Arctic Foxes, feral dogs	Some
	Livestock protection collar Compound 1080	Lethal	Coyotes	Yes
	Tranquilizer trap device	Non-lethal immobilizing agent	Wolves, coyotes, feral dogs	Yes
Cervids	GonaCon immuno-contraceptive vaccine	Non-lethal contraceptive	White-tailed Deer*	Yes
Birds	Compound DRC-1339 concentrate (4 labels)	Lethal	Gulls, pigeons, ravens, crows, magpies, starlings, blackbirds	Yes
	Compound DRC-1339 concentrate—Feedlots	Lethal	Blackbirds, starlings, grackles, cowbirds	Some
	Mesurool aversive conditioning egg treatment	Non-lethal	Crows, ravens	Yes
	Alpha-chloralose	Non-lethal	Geese, ducks, coots, pigeons, ravens	Yes
	Corn oil	Non-lethal	Canada Geese	No
Snakes	Acetaminophen	Lethal	Brown Treesnakes	Yes
	Cinnamon, clove, and anise oil	Non-lethal repellent	Snakes	No

*Registration review by EPA in progress.

APPENDIX D

BASH Inc. ACRP Airport Survey

EXPERIENCE WITH WILDLIFE POPULATION MANAGEMENT

What indirect wildlife population management measures has your airport used (X appropriate boxes)? Please explain under each subheading if applicable.

- ☐ Habitat modification (turf management, water/drainage management, etc.)
- ☐ Harassment (pyrotechnics, etc.)
- ☐ Repellent (chemicals, etc.)
- ☐ Deterrence (fencing, anti-perching devices, etc.)

What direct wildlife population management measures has your airport used (X appropriate boxes)? Please explain under each subheading if applicable.

- ☐ Prey control (insects, rodents, fish, etc.)
- ☐ Trap and relocation
- ☐ Trap and euthanize
- ☐ Falconry/canines
- ☐ Egg manipulation
- ☐ Roost site/nest manipulation
- ☐ Shooting
- ☐ Other euthanization methods (chemicals, fumigants, sprays, etc.)

What specific wildlife species were targeted (X appropriate boxes)? (The following are the species-specific and guild-level designations that will be addressed in our study).

Species-level

- ☐ Canada Geese
- ☐ Cattle Egrets
- ☐ Bald Eagles
- ☐ White-tailed and Mule Deer
- ☐ Coyotes

Avian Guild-level

- ☐ Gulls
- ☐ Waterfowl
- ☐ Wading birds

- ☐ Pelicans and cormorants
- ☐ Grebes and coots
- ☐ Shorebirds
- ☐ Raptors
- ☐ Grassland passerines
- ☐ Woodland passerines
- ☐ Blackbirds and starlings
- ☐ Doves
- ☐ Aerial foragers
- ☐ Corvids

Mammalian Guild-level

- ☐ Predators (fox, bobcat, etc.)
- ☐ Mesomammals (skunks, opossums, raccoons, etc.)
- ☐ Lagomorphs (rabbits, etc.)
- ☐ Rodents (voles, mice, etc.)

Others (alligators, snakes, reptiles, hogs, etc.) (explain)

How was the targeted wildlife population initially determined and measured?

What wildlife population management strategy was used?

Was the applied wildlife population management strategy effective and how was this effectiveness determined?

What were the general cost considerations for this wildlife population management technique?

What were the legal considerations of this wildlife population technique such as restrictions and permits?

What methods are in place to enhance continued wildlife population management effectiveness such as long term evaluation, cyclical behavior, training, monitoring, record-keeping, and public image sensitivity?

Please provide any additional comments from your wildlife population management experiences that may assist others with their wildlife population management planning and implementation.

Abbreviations used without definitions in TRB publications:

A4A	Airlines for America
AAAE	American Association of Airport Executives
AASHO	American Association of State Highway Officials
AASHTO	American Association of State Highway and Transportation Officials
ACI-NA	Airports Council International-North America
ACRP	Airport Cooperative Research Program
ADA	Americans with Disabilities Act
APTA	American Public Transportation Association
ASCE	American Society of Civil Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
ATA	American Trucking Associations
CTAA	Community Transportation Association of America
CTBSSP	Commercial Truck and Bus Safety Synthesis Program
DHS	Department of Homeland Security
DOE	Department of Energy
EPA	Environmental Protection Agency
FAA	Federal Aviation Administration
FHWA	Federal Highway Administration
FMCSA	Federal Motor Carrier Safety Administration
FRA	Federal Railroad Administration
FTA	Federal Transit Administration
HMCRRP	Hazardous Materials Cooperative Research Program
IEEE	Institute of Electrical and Electronics Engineers
ISTEA	Intermodal Surface Transportation Efficiency Act of 1991
ITE	Institute of Transportation Engineers
MAP-21	Moving Ahead for Progress in the 21st Century Act (2012)
NASA	National Aeronautics and Space Administration
NASAO	National Association of State Aviation Officials
NCFRP	National Cooperative Freight Research Program
NCHRP	National Cooperative Highway Research Program
NHTSA	National Highway Traffic Safety Administration
NTSB	National Transportation Safety Board
PHMSA	Pipeline and Hazardous Materials Safety Administration
RITA	Research and Innovative Technology Administration
SAE	Society of Automotive Engineers
SAFETEA-LU	Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (2005)
TCRP	Transit Cooperative Research Program
TEA-21	Transportation Equity Act for the 21st Century (1998)
TRB	Transportation Research Board
TSA	Transportation Security Administration
U.S.DOT	United States Department of Transportation