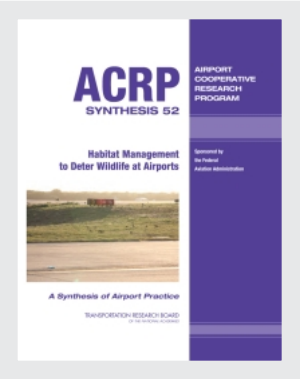

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AIRPORT COOPERATIVE RESEARCH PROGRAM

ACRP SYNTHESIS 52

Habitat Management to Deter Wildlife at Airports

A Synthesis of Airport Practice

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AIRPORT COOPERATIVE RESEARCH PROGRAM

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.

Once selected, each ACRP project is assigned to an expert panel, appointed by the TRB. Panels include experienced practitioners and research specialists; heavy emphasis is placed on including airport professionals, the intended users of the research products. The panels prepare project statements (requests for proposals), select contractors, and provide technical guidance and counsel throughout the life of the project. The process for developing research problem statements and selecting research agencies has been used by TRB in managing cooperative research programs since 1962. As in other TRB activities, ACRP project panels serve voluntarily without compensation.

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: European starlings attracted to short turfgrass next to an airport runway (*credit*: A. Johnson).

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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

Aircraft collisions with birds and other wildlife pose a significant risk to and cost the aviation industry hundreds of millions of dollars in damage and lost revenue every year. Most wildlife strikes occur within the airport environment; thus, the responsibility for mitigation falls upon the airport operator. Wildlife attractants that provide food, shelter, and water are often located on or adjacent to airports.

This report presents information from literature and illustrative case examples on habitat management to deter wildlife at airports and manage risk to aviation. It is the third of three related syntheses of airport practice reports and completes the series wildlife risk management at airports.

This synthesis is intended for airport operators, wildlife biologists, planners, and engineers. These are the people that at some stage are responsible for deciding how to develop, design, or manage habitat on and around airport property. Other interested parties may include regulatory officials with local, state, and federal transportation safety or environmental departments, as well as human–wildlife conflict specialists.

Jerrold L. Belant and Christopher R. Ayers, Mississippi State University, 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.

CONTENTS

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.

HABITAT MANAGEMENT TO DETER WILDLIFE AT AIRPORTS

SUMMARY

All wild animals have basic needs that must be met for them to survive and reproduce, specifically food for nutrition and energy, water for hydration, and shelter (sometimes called cover) for protection from exposure to detrimental weather and predation. Wildlife harness these resources from their natural habitat—the environment around them—but many species will exploit resources in environments that have been heavily manipulated by people, even extremely urban areas such as cities and industrial facilities. Airports are human-dominated landscapes, but are often surrounded by or adjacent to environments containing resources attractive to wildlife.

Efficient and effective wildlife management is a challenging endeavor in any environment, but the safety concerns and human activities at airports add complexities to any management plan. Many species of wildlife in airport environments are potentially hazardous to aircraft operation safety; those most hazardous at a particular airport will depend on the specific location and array of attractants, such as water and certain vegetation, whether naturally occurring or not, on and around airport grounds.

Numerous habitat features, including human-made structures that can attract potentially hazardous wildlife, are identified in this synthesis. Also described are some of the management techniques and habitat changes that can be made to decrease the allure of these features to wildlife. This general information is supplemented with examples from the literature and from airports across North America that have directly experienced problems with many of the habitat features described.

Airport operators and wildlife biologists can work together to determine effective measures that will minimize the risks posed by wildlife at an airport, a process that often involves the determination of what initially attracts wildlife to the area. However, while in some cases deterring wildlife from an attractant may be solved with a simple and inexpensive approach, often wildlife will be persistent. Integrating changes to habitat, along with harassment and perhaps even lethal removal of wildlife, may be necessary to solve a problem with potentially hazardous wildlife populations. Also, what deters one species may not discourage another, and an effective technique at one airport may not work as well elsewhere.

Manipulating habitat features is not the only challenge that airport operators face in the process of reducing wildlife attraction to their airport. Airports are also faced with regulations concerning environmental impacts and effects on threatened and endangered species, and pressures to reduce use of fossil fuels and increase use of renewable energies. Operators can work closely with a wildlife biologist to develop a Wildlife Hazard Management Plan (WHMP) that meets their specific needs, and adapt their plans and techniques within legal and environmental constraints.

This synthesis builds on previous ACRP documents, including *ACRP Synthesis 23*, *ACRP Report 32*, and *ACRP Synthesis 39*, which address bird deterrence and harassment techniques, various wildlife hazards and control techniques, and population management methods, respectively. This synthesis focuses on the elements that entice wildlife to an airport, so that operators can remove or reduce access to the most attractive habitat features. It is based on review and compilation of pertinent literature, and case examples from 17 airports that illustrate how airports are modifying habitats to minimize wildlife risks to aviation.

However, airports are often large parcels of property that are only part of a larger, more complex landscape that should be considered when implementing habitat management. Most airport operators and airport patrons would likely enjoy having an aesthetically pleasing landscape around them as long as safety risks are minimized. This is often possible with appropriate planning, and some airports are using their land to provide conservation areas for wildlife. Safety will remain a primary concern for airport personnel and the general public, and habitat management can be an effective approach to reduce wildlife risk to safe airport operations.

CHAPTER ONE

INTRODUCTION

BACKGROUND

All wildlife have basic requirements to survive and reproduce, which can be broken down into categories of food, water, and shelter (Scalet et al. 1996). Included in an organism's necessary resources are those that help wildlife gain access to food, water, and shelter. Wildlife may have to move about a landscape to fulfill all of their needs, and if not familiar with an area, may spend some time searching before finding what they are looking for (Charnov 1976).

As wildlife traverse the landscape in search of resources, they are attracted to certain features that may provide what they need or help them acquire it. For example, birds of prey such as hawks, eagles, and osprey (*Pandion haliaeetus*) are attracted to tall trees, wires, and platforms adjacent to open areas where they can rest while searching for prey on the ground below (Preston 1990). These structures attract the birds not as a direct food, water, or shelter resource, but as an indirect resource that enables them to more easily acquire the food they are hunting. Both direct and indirect resources may occur on or around airport property, which may lead to potentially hazardous situations in aircraft operations areas (AOA). The AOA is defined as any area of an airport used or intended to be used for landing, takeoff, or surface maneuvering of aircraft. (This and many other definitions can be found in the glossary at the end of the main text.) An AOA 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. Many airports consist of additional property surrounding the AOA that may contain buildings, parking lots, roadways, undeveloped land, and water. As habitat conditions both within and beyond the AOA can influence wildlife use, which in turn can introduce potential hazards to aircraft, habitat management beyond the AOA needs to be considered (Martin et al. 2011). Habitat management is the manipulation of landscape features and natural resources to control their use by wildlife. Most airports contain some common habitat features likely to attract wildlife, and can employ control techniques to minimize potential hazards to aircraft operations (DeVault et al. 2013). For example, airports often contain large areas of impervious surfaces, which can collect stormwater or create the need for stormwater control structures. Surface water is a natural attractant to most wildlife species, especially many species of waterfowl (Belant and Martin 2011). Finding ways of controlling stormwater while minimizing its allure to wildlife is a challenge that most airports face, and many examples are described here.

Elevated areas, including electrical poles, antennas, and other vertical communication structures, are attractive to birds for use as perches and nesting sites (Cleary and Dickey 2010). Other habitat features on or around airports that commonly attract wildlife include turfgrass, natural vegetation, landscaping plants, agriculture, and other airport structures that provide access to food and/or cover (DeVault et al. 2013). These are some of the airport habitat management issues that are discussed in this synthesis.

Airport operators are often faced with the task of maintaining the aesthetics and functions of airport property without compromising safety. There are also many regulations set by local, state, and federal agencies including the FAA. These challenges make management of resources used by wildlife difficult, especially when considering the complexity of factors affecting wildlife behavior habits, including specific wildlife populations and variation between species, weather and seasonal changes, and regional variation in issues and conditions. There are not simple solutions to most wildlife conflict issues and solving problems often involves adapting management to changes in wildlife behavior and

populations. The objective of habitat manipulation is to avoid attracting wildlife to airports or prevent conflicts with wildlife from developing; however if dangerous situations exist, short-term harassment or lethal control of wildlife may still be necessary to insure safety. Information on techniques of direct harassment and population management at airports can be found in previous reports by the National Academies' Transportation Research Board (Cleary and Dickey 2010; Belant and Martin 2011). This synthesis provides a review of resources on airports attractive to wildlife and approaches used to reduce their attraction to potentially hazardous wildlife species.

METHODS

Data for this synthesis report were collected from primary peer-reviewed literature, books, agency publications, and personal communications with experts; and was supplemented by the distribution of a questionnaire to airport operators (Appendix A) intended to provide examples used on airports of the described habitat management techniques. Peer-reviewed literature was identified using the Mississippi State University Libraries database search by Ebsco, JStor, and Google Scholar. Books were located through personal communication, Bing Search, and Mississippi State University Libraries. Most agency-produced publications were identified through personal communications with federal employees and affiliated airport operation experts. Personal communications were established through a network of collaborators from universities, local, state, and federal agencies, airport employees, and an advisory panel of airport operation experts formed by TRB. The questionnaire was designed by the synthesis authors in collaboration with the advisory panel. Airport operators suggested by the advisory panel as survey subjects were contacted by e-mail, telephone, or both. The questionnaire was distributed and returned by e-mail. This information was then used to develop case examples, primarily described in text boxes throughout this synthesis report.

CHAPTER TWO

AIRFIELD TURF

Turfgrass is commonly used as ground cover in aviation property because it can be maintained in a way that prevents sight obstruction on the airfield, allows infiltration of runoff from impervious surfaces, and is relatively inexpensive compared to such alternative ground covers as millings or stone (DeVault et al. 2013).

However, turfgrass is composed of plants living in soil, which are two resources often used by smaller wildlife such as insects and worms (Reiley and Shry 2007), that in turn may attract potentially hazardous bird species to the airport environment. For example, Canada geese (*Branta canadensis*) are among the few birds that eat grass blades. Additionally, when turfgrass is taller, it may serve as food and cover for small mammals that may also attract potentially hazardous species, such as raptors and coyotes (Washburn and Seamans 2013). Further, turfgrass maintenance can be costly and requires the operation of heavy equipment, which in the AOA can pose safety hazards to personnel and aircraft operations.

Consequently, managing a turf area is not as simple a task as it seems; the actual complexity will depend on the species of wildlife attracted to the area and the time of year. Warmer and wetter times of year will require more frequent mowing to maintain a target height of grass, and seasons often influence which wildlife species use these areas (Reiley and Shry 2007). It is important that airport operators consider turf management options that minimize the turf's attraction of hazardous species based on the suite of potentially hazardous wildlife species in their area. Described here are some ways of managing turfgrass with the goal of minimizing attraction to wildlife.

HEIGHT MANAGEMENT

Several government organizations have developed specific recommendations for the height at which turfgrass should be maintained on airports, but the idea for all is similar; when grass is very short, it provides foraging areas for birds such as European starlings (*Sturnus vulgaris*; Figure 1), but when

FIGURE 1 European starlings attracted to short turfgrass next to an airport runway (*Credit:* A. Johnson).

grass is longer, it may provide food and shelter for small mammals that attract raptors and other predators (Washburn and Seamans 2013). An intermediate grass height is typically recommended to minimize attraction of wildlife to either short or long grass (specific appropriate grass heights depend on the preferences of the wildlife species of concern).

Similarly, mowing to prevent grass from seeding will lessen the allure for wildlife attracted to feeding on seeds. The height at which grass flowers and seeds will depend on the type of grass and previous mowing height history. Some grasses can adapt to growing and seeding at shorter heights [e.g., Bermuda grass (*Cynodon dactylon*)], whereas others typically have taller growth forms [e.g., tall fescue (*Schedonorus arundinaceus*); Purdue University 2013]. The International Civil Aviation Organization (ICAO 1991) recommends turfgrass height of eight inches or greater, while Great Britain's Civil Aviation Authority (CAA 2008) recommends grass height between six and eight inches. Transport Canada recommends airports determine an appropriate grass height depending on their unique group of potentially hazardous species (Transport Canada 2002). The FAA in the United States recommends heights of six to 12 inches, but the United States Air Force recommends maintaining grass between seven and 14 inches (Air Force Instruction 91-202, 7.11.2.3).

Airport Turf—Height Management: Arlington Municipal (GKY)

While short turfgrass may not seem like an obvious attractant, a wildlife hazard assessment at Arlington Municipal Airport in Texas determined that the short grass height was attracting grackles, starlings, mourning doves (*Zenaida macroura*), mice, red-tailed hawks (*Buteo jamaicensis*), rabbits, coyotes (*Canis latrans*), and bobcats (*Lynx rufus*). Airport operators responded by maintaining grass at the maximum height their mowing equipment allows (4–6 in.). Continued monitoring of wildlife use of these areas will be used to determine the effectiveness of increasing the mowing height.

When to Mow

Deciding when to mow turfgrass depends on several factors, beginning with the potential interference of mowing equipment and personnel with safe aircraft operations; and the possibility that mowing may itself serve to attract wildlife by disturbing and exposing prey such as insects and small mammals that can lure avian predators such as gulls [*Larus* spp.], egrets, herons, and raptors (Dinsmore 1973). Mowing grass before it produces seeds will prevent attracting animals that forage on grass seed; such mowing can be scheduled when aircraft operations are less frequent or when wildlife potentially attracted are less active (e.g., at night). Moreover, mowing when the ground is saturated can kill turfgrass and create open areas allowing noxious weeds to develop, which may serve as a new wildlife attractant (Christians 2007).

How Often to Mow

Mowing turfgrass can be an expensive and time-consuming process, depending on the amount of turfgrass area being maintained. For these reasons alone, most operators only mow turfgrass as often as necessary to maintain the desired height (Christians 2007). And, as suggested previously, reducing the likelihood of creating a wildlife attractant by disturbing potential prey animals is another reason to mow only as often as necessary to maintain desired height (Dinsmore 1973). Mowing too often may also kill areas of grass and, like mowing saturated turf, may create spaces of open ground or noxious weeds to develop, potentially creating new problems with wildlife attraction (Christians 2007). In the Netherlands, turfgrass is mowed just once or twice a year to maintain cover for erosion control while preventing establishment of consistent food or cover sources for wildlife and reducing mowing costs [Koninklijke Luchtmacht (Royal Air Force) 2008].

What Time of Day to Mow

At each airport, there are times of day when potentially hazardous wildlife species are less active. For example, cattle egrets have been observed feeding on insects disturbed by mowers and tractors,

yet they also regularly leave foraging areas shortly before sunset to return to roosting sites (Dinsmore 1973). Thus, mowing at night can effectively minimize prey availability to daytime foraging species that are hazardous. Operators can schedule mowing when hazardous wildlife is not present to be attracted to exposed prey, but may need to adapt mowing schedules depending on species present at different times of year.

SURFACE AREA

Many airports are restricted by local regulations on how much impervious surface area they have on their property [FAA Advisory Circular (AC) 150/5300-13]. This may influence decisions to replace hard surfaces with turfgrass. However, if an airport already has issues with attracting wildlife to areas with turfgrass, adding more would only increase the problem. Alternative covers that are not wildlife lures may be considered instead (DeVault et al. 2013). Also, although larger areas of turfgrass may be easier to maintain than several small parcels, wildlife may feel more secure and efficient foraging in larger areas of turf (Fernández-Juricic and Beauchamp 2008).

PLACEMENT

FAA AC150/5200-33B recommends against large areas of turfgrass within separation criteria, suggesting a five-mile buffer between the aircraft approach/departure space and any wildlife habitat attractant. Turfgrass is most often used around airport buildings and in the AOA; however, airports having issues with turfgrass attracting potentially hazardous wildlife have replaced some of their turf in these areas with alternative ground covers such as artificial turf and asphalt millings. Sports fields and golf courses are alternative land uses near airports as well and create large areas of turfgrass adjacent to AOAs (Figure 2). This land use practice may be a good alternative to wetlands or agriculture, but may need special treatment with chemical deterrents (e.g., anthraquinone; Ayers et al. 2010) or physical barriers to reduce attraction to wildlife. Operators need to strive to ensure that when replacing one habitat with another they do not create a new attraction that draws in the same or other species of wildlife. Breaking up areas of turfgrass may reduce their attractiveness to wildlife such as geese (as described in chapter three).

COMPOSITION

Regional variation in climate, growing season, and soil conditions determine the turfgrass able to establish and survive in a given area (Christians 2007; Washburn and Seamans 2013), as well as a cover's ability to compete with noxious species (i.e., weeds). While operators cannot control the weather, they can use fertilizers and mulches to their advantage to encourage better establishment of a thick turfgrass density when seeding (Washburn and Seamans 2013).

In addition, certain species of grass are less palatable to wildlife that pose safety concerns such as Canada geese. Washburn and Seamans (2012) found that creeping bentgrass (*Agrostis stolonifera*),

FIGURE 2 Canada geese grazing on turfgrass at a sports field adjacent to a California airport (*Credit:* A. Johnson).

Kentucky bluegrass (*Poa pratensis*), and fine fescues (*Festuca* spp.) were preferred by Canada geese over other commercially available turfgrasses such as zoysiagrass (*Zoysia japonica*), centipedegrass (*Eremochloa ophiuroides*), or St. Augustine grass (*Stenotaphrum secundatum*). One commonly used turfgrass in the United States today is tall fescue (*Schedonorus arundinaceus*), a cool season grass that forms thick continuous strands and is often infested with the fungal endophyte *Neotyphodium coenophialum* (Washburn and Seamans 2013). The infested fescue is often more tolerant of drought and less preferred for food by grazing wildlife and insects (Clay et al. 1985; Vicari and Bazely 1993; Malinowski and Belesky 2000).

The FAA has more standards on turfgrass establishment in AC 150/5370-10E.

Some broadleaf plants such as forbs and clovers may invade turfgrasses and can attract grazing wildlife. These plants may be treated with an herbicide, such as 2,4-D, if the desired turfgrass is resistant to that herbicide (Hartman et al. 1994; Washburn and Seamans 2004). Application of chemicals would need to be more cost-effective than other deterrence methods and might require additional permits for environmental protection (Washburn and Seamans 2004).

Other good cover may not be very attractive to wildlife in airfield areas; for example, Linnell et al. (2009) found wedelia (*Wedelia trilobata*) to be a useful cover plant in tropical areas. Pochop et al. (1999) found that geese from an airforce base in Alaska preferred Kentucky bluegrass (*Poa pratensis*) and flightline turf (*Bromus* sp., *Rumex acerosella*, and *Festuca rubra*) over lupine (*Lupinus noot-*

Airport Turf—Composition: John F. Kennedy International (JFK)

Types of grasses vary in their structure and palatability, which are important characteristics to foraging wildlife. Replacing grasses that have more desirable shapes, lengths, tastes, and textures can reduce turf appeal to potentially hazardous wildlife species. To reduce the various bird species attracted to areas of turfgrass both in and outside of the AOA, operators at JFK replaced some grassy areas entirely with artificial turf. The benefits of artificial turf are that it needs very little maintenance, requires no water, and does not produce seeds or attract insects that might attract larger, more hazardous wildlife. However, operators need to be cautious that artificial turf and the substrate in which it is "planted" may not allow drainage as real turf does, and should plan for proper drainage before installation. Also, operators will want to consider the cost/benefits of replacing turfgrass with artificial turf.

A second technique JFK has used to reduce wildlife attraction to turfgrass areas is planting tall fescue in place of grasses more palatable to geese. Tall fescue helped reduce goose use of a baseball field and adjacent areas on airport property, but the temporary snow-drift or silt fencing in these fields eliminated winter use. JFK has also established areas of tall fescue inoculated with a noxious endophyte. This grass has helped eliminate presence of black-tailed jackrabbits (*Lepus californicus*) and occasional goose grazing at the approach end of one of the runways.

Artificial turf installed next to a runway at a northeast airport (*Credit:* L. Francoeur).

Airport Turf—Composition: Salt Lake City International (SLC)

Faced with a number of bird species—raptors, gulls, waterfowl, shorebirds, and passerines foraging on other prey animals or the vegetation itself—that were attracted to fallow fields near its runways, SLC implemented a project to reduce grasses and broadleaf vegetation on approximately 100 acres, using asphalt millings from runway overlays. While a runway overlay can be expensive, leftover millings can be useful and cheap for projects such as this. The scheme was approved by the FAA, airport environmental staff, and engineers. SLC reports greatly reduced wildlife use of these areas, and would use this technique again. One concern with loose material such as asphalt millings in the AOA is the potential for foreign object damage. Operators from SLC report that one area replaced with millings was treated with a tack spray, while others that were not treated did not pose increased risk of foreign object damage compared to vegetated areas.

Asphalt millings left over from runway overlay projects (*left*) can be used to replace vegetation that may attract wildlife (*right*) (*Source:* SLC).

katensis), bluejoint reedgrass (*Calamagrostis canadensis*), and beach wildrye (*Elymus mollis*). See FAA CertAlert No. 98-05 for more information on grasses attractive to hazardous wildlife (http://www.faa.gov/airports/airport_safety/certalerts/).

GROUND STRUCTURES

Many species of wildlife rely on areas of relatively soft soil to dig nests and dens (Lauro and Burger 1989). Shorebirds and waterbirds such as killdeer (*Charadrius vociferus*), gulls, oystercatchers, and terns prefer to nest on bare ground (Colwell and Oring 1990). These areas do not provide vegetation that may attract many other herbivorous or granivorous species, but still provide an important resource that these nesting birds use.

Airport Turf—Composition: John F. Kennedy (JFK)

In order to accommodate larger aircrafts, JFK had to expand the width of its runway. This construction left exposed areas alongside the runways of mostly soft sandy soils, creating a desirable habitat for nesting by American oystercatchers (*Haematopus palliates*). Though the bare ground was reseeded with fescue, the turf did not take hold and oystercatchers were quickly attracted to the area. However, over the course of a few months, other herb and forb vegetation began to grow in the bare areas; and as these plants grew taller and thicker, oystercatchers were deterred from nesting in the vegetated area and moved elsewhere. This is an example of how management techniques intended to deter wildlife may not work as planned; but the unexpected consequences may allow operators to adapt to local conditions and develop effective measures for their species of hazard concern.

American oystercatcher nesting at JFK (*Credit:* J. Mastantuono).

CHAPTER THREE

LANDSCAPING

As previously mentioned, airport designers and operators are often faced with the task of balancing the visual aesthetics of airport property with the potential of attracting wildlife to or around the AOA. Well-planned landscape designs can help maintain this balance as long as they factor in the potential for creating food, water, or shelter for wildlife. Additionally, creative landscaping can also help reduce attraction of wildlife to certain areas. For example, if sight lines of large open turfgrass areas are broken up, herbivorous birds (e.g., Canada geese) are less likely to congregate because of a greater perceived threat of potential ambush from predators (Brown 1999). Another strategy for deterring wildlife from open spaces is installing obstructions such as wire grids, which have proven effective against grazing geese at Newark Liberty International Airport.

STRUCTURE

Height

Like electrical poles and antenna structures, tall trees adjacent to open grasslands can attract perching birds, especially raptors (Preston 1990). Conversely, continuous areas of low-growing vegetation can serve as shelter to wildlife as well (Beier and McCullough 1990). A mix of plant types and species

Landscaping—Structure: Port of Portland (PDX)

Creative landscaping can help prevent the use of vegetated areas by such potentially hazardous species as Canada geese. At PDX, an area of turfgrass that might normally have become an attractive area for grazing was broken up by sight-blocking berms and intermittent taller grasses. This area was planted to replace an asphalt parking lot, but geese have not been a problem since the conversion. One alternative to more permanent structures such as berms are visual barriers, such as silt fencing, which can also be used to deter geese but will need to be replaced every five years or when damaged.

Goose deterrents at PDX. Raised vegetation berms (*left*) and silt fencing (*right*) (*Source:* Port of Portland).

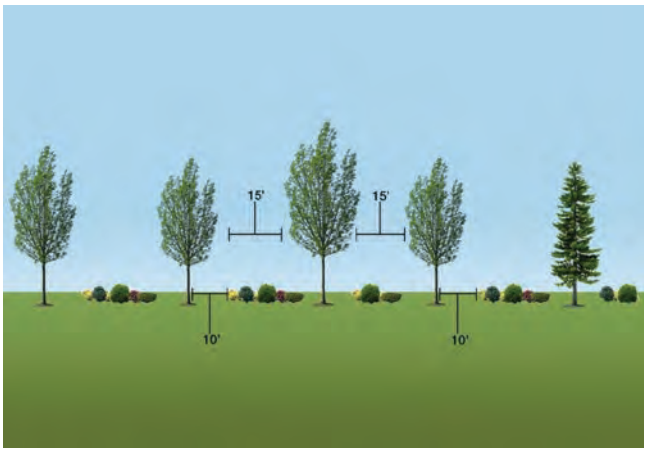


FIGURE 3 Example of spacing for landscape plants used by Port of Portland (*Source:* Port of Portland). Also note the upright angle of tree branches to limit attraction as perches and nesting structures according to the Port of Portland.

that limit perching or ground-level cover may be an appropriate balance depending on the potentially hazard species present.

Density

Continuous strips of vegetation can provide refuge and thermal cover for many species, making them an attractive habitat feature for nesting and resting (Shake et al. 2011). Some airports have adopted standards limiting the density of plants by breaking up landscaping with specific distances between plants and varying vegetation heights and types (Figure 3).

COMPOSITION

Airport operators need to consider which plants to allow in landscaping airport property in order to avoid attracting hazardous wildlife. For example, fruit-bearing trees seasonally attract flocks of birds as well as mammals (Curtis et al. 1994). Another consideration is branch structure of trees and shrubs; branches that are more vertical will be less attractive for perching and nesting by birds (Figure 4). Operators can work with horticulturalists and landscapers to develop a list of approved plant species for use on airport property based on such considerations. For an example of airport specific landscaping standards see http://www.portofportland.com/PDFPOP/Env_2009_WHMP_Lndscpng_%20Stndrds.pdf. See also the lists of landscaping plants in Appendices D and E.

There is little information on the efficacy of using annuals vs. perennials to reduce attraction to wildlife. The advantage of perennials is that they provide landscaping all year and do not require replanting each spring. Perennials also provide less forage and cover for most species during periods when they are dormant, though, in the case of trees and woody shrubs, may provide better perches when foliage is shed (Iwasa and Cohen 1989). However, most annuals will not produce fruits or provide cover during cooler months when they die (Reiley and Shry 2007). Operators may choose to use more perennials to reduce long-term landscaping costs and retain aesthetic appeal during winter months, but can choose plant species that minimize attraction of potentially hazardous wildlife.

FIGURE 4 Examples of a tree with relatively horizontal branching (*left*) and one with vertical branching (*right*) (*Source:* Port of Portland).

CHAPTER FOUR

AIRPORT STRUCTURES: PERCHING, NESTING, AND DENNING

ANTENNAS, LIGHTS, SIGNS, AND ELECTRICAL POSTS

Airports are often very open areas interspersed with tall structures, a combination attractive to many species of birds for resting or hunting with an excellent view of their surroundings. Antennas, lights, signs, and electrical posts are common structures on airport facilities, and excellent perches for raptors and passerines (Belant and Martin 2011).

Modification of these structures may be necessary to discourage these birds, and many deterrents have been developed to reduce such use. Reducing the horizontal surface area of these structures, and/or replacing them with smooth curved and sloping surfaces with sharp domes or points, can make it are more difficult for birds to perch. Strips of metal or plastic spikes can be glued on flat surfaces and plastic cable ties can be used on more narrow and irregular surfaces (Figure 5). Another useful device is called a "granddaddy long-legs," because with its arching metal wires attached to a central base, it resembles a spider. All of these devices are intended to make perching birds feel uncomfortable on a structure or prevent them from landing on a structure at all (Cleary and Dickey 2010).

ROOFS

Almost any flat elevated surface will be attractive to some species of birds, and many will not be deterred by human activity in the area. Roofs on airport buildings can serve as excellent places for species to nest, especially those closely associated with people, such as pigeons. Reducing the horizontal surface area of these structures is another general method for reducing attraction to perching birds. Smooth curved and sloping surfaces with sharp domes or points are less adaptable as perches. Where the expanse of roofs makes anti-perching devices infeasible, suspended nets and overhead wires can be used to prevent birds from accessing the flat stable surfaces (Ickes and Belant 1996).

Internal ledges or ceilings are similarly attractive to many small bird species for nesting. The cover and protection provided by garages, covered hangars, and large culverts, etc., give birds a sense of security. These areas can be blocked with hanging strips or chains that prevent the birds from being able to fly freely into the covered area (Figure 6; Cleary and Dickey 2010).

CULVERTS

Culverts and drains are used by numerous species, including coyotes and raccoons (*Procyon lotor;* Clevenger et al. 2001; Wolf et al. 2003). Some of these structures may not be recognized as wildlife habitat, but may be used by wildlife as short-term travel corridors and accesses to other areas, or long-term nesting or denning structures. Understanding the timing of denning for wildlife species of concern can help airport operators plan when to clear out these structures, such as winter and spring, when many mammals will seek out these areas. Grates and covers over culvert openings can effectively exclude use by wildlife (Figure 7); however, storms and prolonged water flow may cause grates and covers to become clogged with debris, which must be cleared to maintain drainage.

FIGURE 5 Antiperching devices on airport structures can include clockwise from top left: flexible wire set, metal spikes, and plastic cable ties in both bottom photos (*Credit:* H. Woods and F. Humpal).

FIGURE 6 Plastic strips (*left*) and metal chains (*right*) prevent swallows and other birds from accessing protected areas attractive for nesting (*Sources:* Port of Portland and H. Woods).

FIGURE 7 Covering over a culvert to prevent use by wildlife (*Source:* A. Johnson).

Airport Structures—Perching: Gainesville Regional (GNV)

The very high frequency omnidirectional navigation system antennas (VOR) at GNV used to attract as many as 30 roosting turkey vultures (*Cathartes aura*) and black vultures (*Coragyps atratus*) daily. Area wildlife biologists recommended that GNV try deterring the birds with an effigy of a dead vulture. The effigy was not immediately effective, but since the roosting birds were frightened away with pyrotechnics, no new vultures have been observed on the VOR. The taxidermy vulture needs to be replaced about every year at a cost of about $275, and a depredation permit for collecting vultures was required from U.S. Fish and Wildlife Services. A state permit may be required for take and use of wildlife as well. The FAA granted permission to use the effigy, and operators have considered the technique effective.

Taxidermy vulture effigy (*left*) hung upside-down from VOR antenna to deter vultures from perching at GNV (*right*) (*Credit:* S. Blevins).

Airport Structures—Nesting: Southeastern U.S.

Wildlife habitat modifications do not always go as planned. An airport in the southeastern U.S. had a concern with ospreys nesting on a communications tower. Removal of the nest was approved, and a cover was placed over the tower to help prevent future nesting attempts. However, because the cover still created a flat supportive surface, ospreys were able to continue nesting there. A pointed and sloped shape such as a cone or pyramid would have been more effective at preventing nesting. Understanding the resource preferences of a species is very important to knowing how to deter them.

Osprey nesting on a communications tower at a southeastern U.S. airport.

Airport Structures—Nesting: East Coast, United States

Osprey are common near aquatic habitats in the eastern U.S., and will often seek out tall posts, poles, or antennae that can support their large nests. Management options are limited by federal protection afforded to all migratory birds, but each state may have additional restrictions or permitting processes concerning control efforts can be taken. Operators at a small airport in the eastern U.S. wanted to remove an osprey nest from an electrical pole on airport property. However, the pole belongs to the local electrical company, so the airport limited in its actions. All actions and control techniques had to be approved and carried out by the electric company. In addition, the state wildlife agency required a permit to remove the nest, which cost $1,500 (for permitting and staff costs) and involved monitoring the nest to assure that it was inactive before removal was approved. Ultimately, the nest was removed, and wiring on the electrical pole was altered to deter future osprey nesting attempts.

Osprey nesting on an electrical support pole at an airport in the eastern U.S. (*left*) and the pole after modification to remove nesting support beams (*right*).

Airport Structures—Perching: Chicago's O'Hare International (ORD)

All new buildings in the city of Chicago, including those at O'Hare, are now being constructed with a "green roof" or "eco roof" as required by Executive Order (Chicago Department of Transportation, 2007). Three green roofs, comprised of *Sedum*-based vegetation, were constructed at O'Hare between 2006 and 2010, including the four-acre roof on the FedEx cargo sorting facility, which is the largest green roof on any airport in North America. Research conducted by U.S. Department of Agriculture (USDA) Wildlife Services during the past few years has shown that wildlife hazardous to aviation use green roofs and traditional (i.e., gravel-based) roofs similarly, with most use during the summer.

Green roof at ORD (*Credit:* B. Washburn, USDA Wildlife Services).

Airport Structures—Perching: Port of Portland (PDX)

A glass and metal canopy that protects patrons from rain at PDX was attractive to several species of passerine birds. Installation of bird spikes and other perching deterrents was not feasible because of the surface area involved. Instead, operators installed a net to hang under the canopy support beams and prevent birds from reaching most, though not all, of their desired perch sites.

Walkway canopy at PDX (*left*) with a net preventing birds from perching on a majority of support structures (*right*) (*Source:* Port of Portland).

Airport Structures—Nesting: John F. Kennedy International (JFK)

Most animals are resourceful and will take advantage of opportunities for access to food, water, and shelter, including many human-made structures that can serve as excellent nesting habitats. An old aircraft hangar at JFK was serving as shelter for nesting peregrine falcons (*Falco peregrinus*). Because peregrine falcons were considered threatened with extirpation, airport operators worked closely with the state wildlife agency to develop an approved harassment program for the falcons. First the hangar doors were closed, but holes in the roof and sides of the structure still allowed the birds to enter. Eventually, harassment with lasers and pyrotechnics deterred the birds from nesting in the building long enough for the hangar to be demolished.

Ledges and rafters of an old hangar at a northeast airport (*left*) served as nesting habitat for peregrine falcons (*right*) (*Credit:* L. Francoeur).

CHAPTER FIVE

ALTERNATIVE ENERGY

WIND

Wind energy is a growing industry in the United States, and some airports are now using wind power to help offset costs and resource use associated with other power sources (DeVault et al. 2012). If conditions at an airport are suitable, wind turbines can produce a significant portion of power needs. Many airports are also under pressure to reduce pollution and the impacts their buildings and operations have on natural resources; and integrating wind-generated power into their overall plan may help meet this goal. In addition, consistent wind energy and storage of wind power can help maintain airport operations in case of an emergency power outage that would otherwise cripple an airport's crucial lighting and navigation systems. For example, after an earthquake knocked out power to Honolulu International Airport (HNL) in 2006, wind turbines were installed on the main airport building to serve as back-up power generators in case of a similar power failure.

One potential drawback to wind energy is that large turbines can interfere with ground and air-based radar (DeVault et al. 2012). The FAA is researching technologies to reduce this conflict (Infanger 2010; Kintisch 2010). Tall wind turbines may also pose a risk to flight paths if not positioned well. Because tall turbines are not appropriate for use near aircraft flight paths, they will not cause the bird mortality that has been documented in other areas where large turbines are common (Osborn et al. 2000). However, smaller turbines attached to buildings have not been reported to attract wildlife, and may be useful sources of energy on airport buildings (DeVault et al. 2012).

SOLAR

Some U.S. airports have had success installing solar fields to reduce or eliminate their demand for electricity from an outside source, and to reduce the area of vegetation requiring maintenance such as shrubs and turf grass. Issues with installing solar-powered electricity-producing structures may include up-front costs and some concern of creating a new shelter for wildlife. From the examples of airports using solar field electricity production that were available [Fresno–Yosemite International (Figure 8) and Lakeland Linder Regional (p. 21)], costs were quickly returned through savings on utilities. When properly maintained, according to manager observations, solar structures did not create a new attractant to wildlife, which is supported by Dolbeer et al. (2000, 2009) and DeVault et al. (2012). There was initially concern that solar arrays near airports would produce a dangerous glare that could interfere with safe aircraft operations. However, that has not proven to be the case, as photovoltaic panels are designed to absorb most of the light rather than reflect it (DeVault et al. 2012).

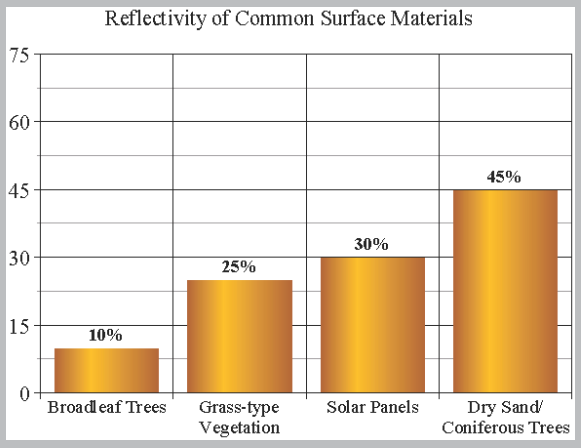
FIGURE 8 Solar field at Fresno–Yosemite International Airport (*Source:* FAT).

Airport Structures—Alternative Energy: Lakeland Linder Regional (LAL)

Properly operating an airport can be very expensive, and efforts to reduce costs influence almost every decision. Some North American airports have installed solar panels on roofs of buildings to help offset utility costs as well as to earn credits for programs such as Leadership in Energy and Environmental Design (LEED). Other airports in particularly sunny climates have taken these efforts further by installing expansive solar fields. LAL in Lakeland, Florida, established a collaborative partnership with Sun Edison and the city of Lakeland to construct a 40-acre solar field. The airport provided the land, Sun Edison paid for construction, and the city received power production in exchange for energy credits worth nearly $250,000 annually.

Several concerns were addressed during the planning stage of the solar field. The panels needed to be located so as to maintain safety for air operations as well as maximize efficiency in power production. Additionally, the FAA had initial concerns about glare from the panels interfering with safe landing, so LAL conducted an analysis of glare produced by common surfaces and found that solar panels with anti-reflective coating produce 60% of the glare produced by dry sand and coniferous trees. An environmental impact analysis determined two additional issues that needed to be addressed. One was that several protected gopher tortoises would need to be professionally relocated; and the other was that a local ordinance required the airport to mitigate the removal of over 350 trees. LAL also consulted a certified wildlife hazard biologist about potential new attraction of wildlife to the solar field.

After all concerns were addressed and final approvals were provided, the airport and its collaborators were able to install over 18,000 solar panels. This project nearly eliminated the airport's electricity costs, reduced carbon emissions by an estimated 324 million pounds over 25 years (equivalent to the pollution from 31,000 cars), and produced power for over 22,000 homes. The project took about four years to plan and approve, and one year to install. There has been no observed increase in use of the area by wildlife.



Solar field installed at LAL (*left*) and comparison with reflectivity of common land surfaces (*right*) (*Source:* LAL).

CHAPTER SIX

AGRICULTURE

The FAA discourages establishing any habitat within five miles of an airport/AOA that may attract hazardous species (FAA 2007; Blackwell et al. 2009). This includes agricultural cultivation of row crops and grains [e.g., corn (*Zea mays*), soybeans (*Glycine* spp.), and wheat (*Triticum* spp.)]; and livestock feedlots. While these fields may not always attract a diversity of wildlife, they are often enticements to commonly hazardous species such as white-tailed deer (*Odocoileus virginianus;* Hein et al. 2012) and birds such as geese, starlings, grackles, allies, and blackbirds (Bent 1965; Dolbeer et al. 1978). Various species of migratory geese will take advantage of grain fields (Patterson 1991); some normally migratory species, including Canada geese, have become successful at finding resources year-round. While many birds eat grain crops at any time, some, such as red-winged blackbirds (*Agelaius phoeniceus*), may be more of a threat when plants are very young or when soil is turned and insects are exposed (Bent 1965). More research is needed to quantify the risks associated with specific agricultural operations on and near airport property and to examine particular habits of species. Not all wildlife use a crop similarly, and airport operators can observe wildlife use throughout the year to determine how to adapt their management techniques.

LIVESTOCK

Confined livestock operations such as feedlots and dairy operations concentrate water, food, and waste that may attract potentially hazardous wildlife species such as flocking birds (Cleary and Dickey 2010). While the FAA recommends against allowing confined livestock facilities near airports, free-ranging livestock grazing may be an alternative land use in areas near airports outside of the AOA. Grazing livestock may serve as an alternative method of turfgrass management, providing an economic benefit to the airport and reducing habitat for wildlife that prefer tall grasses and thick vegetation, i.e., rabbits, deer, and rodents. However, livestock themselves can also become a serious hazard if a fence fails and animals enter the AOA, though frequent fence inspection can reduce the risk of this hazard (AC/Cert alert 04-16). This is an example of the complex and seemingly contradictory issues that arise when trying to address all possible wildlife attractants on a landscape. Different methods work well in different regions at different times of year, and can be tested and evaluated over time with proper research and planning.

GRAIN CROPS

Wheat, sorghum (*Sorghum* spp.), and rye (*Secale cereale*) may attract granivorous wildlife such as birds, mice, voles, rats, and larger herbivores such as deer. Again, small mammals can attract other larger, potentially hazardous raptors (Accipitridae), coyotes (*Canis latrans*), and foxes. Corn and soybeans are also common crops that attract potentially hazardous wildlife such as white-tailed deer (DeVault et al. 2007). Some birds, such as blackbirds, will feed on corn either while the kernels are tender and soft, or after harvest when waste corn is accessible on the ground (Bent 1965). Additionally, rice may attract rodents, but also granivorous waterfowl and other bird species that forage in flooded fields. Post-harvest winter wheat is a major enticement for geese and other granivorous birds.

HAY CROPS

Like grains, hay crops can provide both food and cover for a variety of wildlife species. White-tailed deer are one potentially hazardous species that are attracted to foraging on young legumes such as clover and alfalfa (*Medicago sativa;* Richer et al. 2005). Mice and rats can also be attracted to hay

Agriculture—Livestock: Kansas City International (KCI)

KCI owns approximately 9,000 acres of land outside the perimeter security fence. Until 1997, these fields, as well as portions inside the fence, were used by farmers to raise crops including wheat, corn, soybeans, and sorghum. Then KCI decided to create a 2,000-foot buffer around the perimeter fence, eliminating grain crops and removing some trees, to reduce attractants for white-tailed deer, coyotes, raptors, and foxes. Tall fescue was planted in this area, and once the grass had become established, portions of the buffer were leased for grazing cattle. Now 1,730 acres of this buffer area support over 600 cattle. A separate barbed wire fence encompasses the pastures, and a gravel road between this fence and the perimeter fence allows access for ranchers. Ranchers use freeze-proof watering tanks in the pastures filled by well water, because open water can be a major enticement to many wildlife species. Not only do the cattle maintain a shorter grass height in the buffer area, they also reduce browse habitat along tree lines that normally attracts deer. The shorter grass height has also figured into an integrated small mammal control effort in the airport buffer area by reducing the cover habitat of thick long grasses. While 14 deer were observed on the airfield in 1997, KCI has not had a confirmed sighting of a deer on the airfield since 2007.

Grazing cattle outside the perimeter fence at KCI (*Credit:* B. Johnson).

Agriculture—Grain Crops: Victoria Regional (VCT)

Victoria Regional Airport in Texas is surrounded on three sides by agricultural land. The most common uses for this land are pasture and rice. Pastures often are overgrown and provide habitat for deer, wild pigs, and coyotes. The rice is usually in a two- to three-year rotation, but there is some rice grown every year, attracting waterfowl, cranes, gulls, and passerines such as blackbirds. Other species of concern on the property include mourning doves, barn swallows (*Hirundo rustica*), sparrows, vultures, and killdeer. The airport has been issued a federal depredation permit for migratory birds and a state permit for culling deer. Airport personnel also use non-lethal techniques such as pyrotechnics and acoustic devices to deter potentially hazardous birds. Snow geese (*Chen caerulescens*) are most common on agricultural fields in the southern United States during winter after harvest of grain.

Flocks of snow geese flying over Victoria Regional (*left*) and loafing in an agricultural field nearby (*right*) (*Credit:* A. Johnson and S. Brammell).

fields in large numbers, attracting other potentially hazardous species such as raptors and carnivores (Kaufman et al. 2000). If hay is cultivated on or near airport property, operators can work with farmers to determine ways to minimize the risk of attracting wildlife, such as harvesting at night when avian and insect activity is reduced. Other ways of reducing risk may include increasing the distance from the airport perimeter where hay crops are allowed; installing deer-proof fencing around the AOA; and orienting hay fields in such a way that deer and other wildlife will not attempt to cross the AOA to get to other fields or forested areas.

NON-TRADITIONAL FRUITS AND NUTS

Fruits and nuts are major attractants to many wildlife species. Few deterrents other than physical obstructions (fencing and netting) have proven very effective in keeping birds from seeking out berries and smaller fruits, including grapes (Way 1961). However, some chemical deterrents such as anthraquinone have been used on seed crops such as sunflowers with some success against feeding, but not necessarily against attracting grackles and blackbirds (Werner et al. 2011). Apple orchards have been shown to attract deer and small mammals such as moles and voles (Phillips et al. 1987). Fruit and nut crops are a challenge for airport operators in deterring wildlife, and require persistent efforts to reduce wildlife foraging.

GRASS SEED HARVESTING

The grass seed industry faces many of the same challenges as other grain crops: deterring larger herbivores such as deer and elk and rodents (Bartuszevige and Endress 2008; Sivy et al. 2011) as well as geese (Alisauskas et al. 1988) and other granivorous birds. If grass production is maintained adjacent to airport property, potentially hazardous wildlife may enter the AOA. Grass seed can be treated like other grain crops in an airport's WHMP depending on the particular wildlife species of concern.

BIOFUELS

Like agricultural cultivation, biofuel production is an alternative land use for airports (Martin et al. 2013). Exotic plants such as Miscanthus (*Miscanthus giganteus*) and native warm-season grasses are candidate species for biofuels (Tilman et al. 2006; Heaton et al. 2008; Tilman et al. 2009; Somerville et al. 2010). While airport production of biofuels is unlikely to meet the needs of a production facility, it can contribute to a larger collaboration of sources of biofuels materials (Kocoloski et al. 2011; DeVault et al. 2012). Biofuel fields dominated by grasses may attract dense populations of small mammals, but further research is needed on the potential for such areas to attract potentially hazardous wildlife to airport AOA (Blackwell et al. 2009; Martin et al. 2011; DeVault et al. 2012).

CHAPTER SEVEN

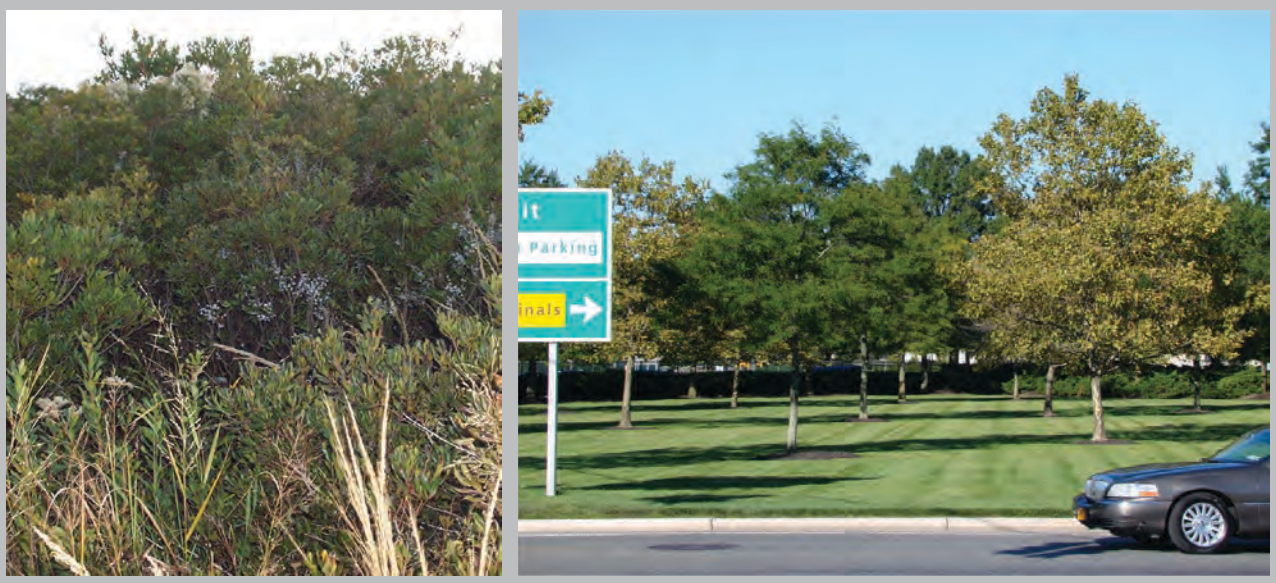
OTHER VEGETATION ON AIRPORT PROPERTY

COMPOSITION

Some wildlife species are generalists, and will eat many different types of food or use many different habitats for shelter. However, many are attracted to specific foods and habitats, which can make wildlife management a little easier. Airport operators can observe and learn the habits of the species that pose a risk to aircraft safety at their airport. Potential risks of wildlife to aircraft operations may change seasonally each year or over time as habitats and conditions evolve. As plants produce new

Other Vegetation—Composition: John F. Kennedy International (JFK)

Changing conditions to maintain safe air operations at airports may include changing plant species in and around the AOA. Operators at JFK noticed a few areas of vegetation on airport property that attracted concentrations of potentially hazardous wildlife, and developed plans to eliminate or greatly reduce the attractant. One risk was posed by migrating flocks of tree swallows that would visit the airport each fall and appeared to be attracted to areas of bayberries (*Myrica pensylvanica*) near runways. Examination of crop contents of some of the birds confirmed that they were eating predominantly bayberries, which convinced operators to remove the shrubs (Bernhardt et al. 2009). In another area of JFK, ornamental pear trees (*Pyrus callyeryana*) that attracted starlings were replaced with less appealing species, including Japanese zelkova (*Zelkova serrata*), American redbuds (*Cercis canadensis*), fringe trees (*Chionanthus virginicus*), golden rain trees (*Koelreuteria paniculata*), and Atlantic white cedars (*Chamaecyparis thyoides*). JFK also planted trees in large open areas of turfgrass, which deterred geese from grazing. This is an example of vegetation management that can meet multiple needs, but operators should also be careful not to create a new, potentially more risky allure when making changes to vegetation.



Bayberry shrubs formerly inside the AOA (*left*) and trees used to break up areas of turfgrass at a northeast airport (*right*) (*Credit:* L. Francoeur).

growth or fruit, wildlife may use them differently, affecting aircraft safety. Diversity in vegetation will likely attract a greater diversity of wildlife (Tews et al. 2004). However, a mosaic of vegetation in a landscape can also help to break up large areas of habitat that would otherwise be attractive to wildlife (MacArthur and Pianka 1966). If wildlife have to spend more time searching for food than they would somewhere else, or if they do not feel safe in an area because of limited views of oncoming threats, they may prefer to go elsewhere (Charnov 1976; Brown 1999).

SPATIAL CONSIDERATIONS

Separation from the AOA is an important consideration with any habitat modification that might attract wildlife, and the FAA has criteria for allowable structures within certain distances of the AOA (FAA AC 150/5200-33). These distances range from 5,000 ft to five miles, depending on aircraft involved and type of aircraft operations.

Density

Dense vegetation is a common nesting habitat for many bird species, but it can also serve as excellent cover for both birds and mammals, who use it to hide from predators or take refuge from the cold; while predators may use it to ambush or hunt prey (Shake et al. 2011). Other wildlife are deterred by thick brush and plants, which may interfere with inter-flock communication and the view of approaching predators (Brown 1999). Tall vegetation is normally effective in long thin rows and does not need to be thick, which prevents attraction to other wildlife for use as cover.

Other Vegetation—Spatial Considerations: Midwest, United States

An airport in Ohio contacted the U.S. Department of Agriculture Wildlife Services for wildlife management advice. The airport owns 150 acres approximately 4,000 ft from its AOA which it has allowed a non-profit organization to use as a grassland conservation area. Though this property may appear well outside the area of risk to the airport, it is a potential attractant for hazardous wildlife, and is still being monitored for use by potentially hazardous birds, primarily smaller passerine birds. This property is an example of a conservation effort that airports can support, using property outside of the AOA that does not appear to increase wildlife strike risk.

Grassland conservation area owned by a nearby international airport (*left*), and bobolink (*Dolichonyx oryzivorus*) observed in that grassland (*right*) (*Credit:* B. Washburn).

Other Vegetation—Spatial Considerations: Midwest, United States

A Midwest airport was having trouble with waterfowl attracted to open standing water in shallow ditches. It elected simply to allow a strip of vegetation to grow up along the water's edge, thereby making the surface water much narrower and less attractive to ducks and geese. The vegetation consisted of naturally-occurring species such as reeds and grasses that cost the airport nothing other than occasional mowing; and that have additional benefits of removing some pollutants from runoff and slowing water runoff rates to reduce erosion and sedimentation of ditches. The vegetation strip is kept narrow and along the water's edge or over the water surface to prevent its becoming a travel corridor for other potentially hazardous species such as deer and carnivores. This particular airport reports the program has resulted in fewer waterfowl using the ditches, and is satisfied with the results. Alternative techniques for deterring the birds from this ditch would include use of pyrotechnics or the frequent presence of humans or other threats such as dogs.

Open surface water in broad shallow ditches (*left*) can be less attractive when lined by a strip of dense vegetation (*right*).

Patch Size

As a general rule, smaller areas of habitat will be able to support fewer animals (Fahrig 2013). However, several small patches of high-quality habitat close to each other can create a mosaic that is able to support more animals. Animals tend to move from a patch as resources are depleted or if the risk of being in a patch increases (MacArthur and Pianka 1966). Larger patches will be easier for airport operators to manipulate and maintain compared to several smaller patches of various habitats requiring various management techniques. Additionally, several small patches have more edge habitat than one large patch, and edge often supports greater diversity of wildlife species (Koh et al. 2010). Operators will need to determine if small or large patches are more alluring to the specific wildlife of concern to them.

CONSERVATION AREAS

Conservation areas on airport grounds may take the form of wetlands, grasslands, or more forested areas. These areas can be valuable habitat for threatened and endangered species such as insects and grassland birds that pose little risk to aircraft safety (Blackwell et al. 2013). However, it is helpful to consider the species attracted to these habitats in a specific region before implementing any conservation efforts. Mammal conservation on or around airports is less likely to be safe at any spatial scale, because of the risk of enticing animals that are prey for larger, more hazardous wildlife, or of attracting larger animals (e.g., deer and coyotes) themselves (DeVault et al. 2011; Blackwell et al. 2013).

WOODLOTS

Wooded areas in most parts of the world are closely associated with high-quality habitat for many species of vertebrate wildlife (Kays et al. 2008; Quinn et al. 2013). The variety of plants in these areas provides not only food but excellent cover. Airports with adjacent forested areas can minimize the impacts these habitats have on safety by learning what wildlife are supported in the woodlot and determining best management practices for those species. A generally effective strategy for reducing risk associated with wooded areas is to separate them from the AOA using quality fencing (AC/Cert alert 04-16). Fences can be designed to prevent coyotes, deer, and other wildlife going over and/or under the barriers; for guidance on exclusive fencing techniques, see VerCauteren et al. (2013).

CHAPTER EIGHT

WATER RESOURCES

Water is an essential resource for all wildlife, and hence a major attractant even in seemingly small quantities. Wildlife will seek water not only for consumption, but for the edible plants and animals bodies of water contain. Areas of open water can also be a safe zone for birds such as ducks and geese that are more vulnerable to predators when on land. One of the greatest challenges facing airport designers and operators is controlling and removing stormwater/standing water from airport surfaces. Local, state, and federal regulations often limit how wetlands can be altered or eliminated; and airport operators need to be prepared for a possibly complicated permitting process when attempting to remove a wetland area from their landscape (Cleary and Dickey 2010). Restricting access to open water resources, minimizing standing water in the AOA, and reducing the attractiveness of water bodies may all be necessary to minimize wildlife attraction to water resources on and around airports (Blackwell et al. 2013).

WETLANDS AND MARSHES

Wetlands and marshes are natural enticements to wildlife. Even small wetland areas can provide food, water, and sometimes shelter to potentially hazardous species such as geese, ducks, and wading birds. Removal of wetlands and marshes in the United States requires a federal permit from the U.S. Corps

Water Resources: Logan International (BOS)

Boston's Logan Airport is nearly surrounded by water, much of which is shallow tidal marsh. These areas are extremely attractive to many types of wildlife, especially waterfowl, gulls, raptors, and shorebirds. In addition, many people frequent these areas, and can attract wildlife through intentional feeding or unintentional provision of food through exposure of natural food sources such as clams. Removing or mitigating this habitat is not possible, so other means of reducing wildlife-airstrike hazards must be used. Further, some of the species that use Logan property are considered threatened by the state of Massachusetts [e.g., upland sandpiper (*Bartramia longicauda*)] and protected from many habitat manipulations and removals. On-site mitigation of habitat may be one of the few options in such cases. Boston Logan is an example of why developing a wildlife hazard management plan is so important. The wildlife management staff at the Massachusetts Port Authority (Massport) has worked with local, state, and federal agencies to develop safe and effective methods of addressing a variety of wildlife hazard issues at a very busy airport. Its WHMP identifies potentially hazardous wildlife—seven mammal and 35 avian species—that use Logan property and surrounding areas, as well as the habitats they are attracted to. Understanding the source of potential hazards is key to reducing risk. The WHMP also includes standard methods for deterrence and control of wildlife, necessary equipment, required permits, personnel responsibilities, and contact information. Wildlife control staff patrols Logan property 16 hours each day, at an annual budgeted cost of $750,000.

View of coastal Boston, MA area showing Logan International Airport (BOS) nearly surrounded by water (*Source:* NASA).

Water Resources—Natural: Spirit of St. Louis (KSUS)

In the late 1980s, the Spirit of St. Louis Airport began an 11-year plan and federal permitting process to mitigate wetlands and stormwater drainage on the south side of the airport, which had become an attractant for waterfowl and other wildlife. Shortly before completion of the $2.5-million stormwater detention and drainage system in 1999, KSUS developed a plan for incorporating the system into a revenue-generating golf course specifically designed to help the drainage and alleviate the tendency for waterfowl to gather.

As part of the wetland mitigation project, the airport was required to establish an alternative, larger wetland off-site, to maintain it for five years, and then to turn it over to the state as a conservation area. KSUS purchased a parcel of more than 200 acres many miles away, and relocated each species of plant to the site. An 18-hole USGA golf course was constructed in place of the original wetlands, with a series of meandering ditches that could handle the runoff from the airport and drain within 48 hours. Special techniques were used to create the course to ensure another wildlife attractant was not created. The course has no water features on it (i.e., no lakes), and the well water used to irrigate the course is stored in a large, 220,000-gallon underground bladder system to prevent attracting more wildlife. The golf course is one of the largest land-leasing tenants at the airport, producing steady revenue now and for years to come. Its lease also requires the golf course to maintain the drainage ditches, and does not allow it to add any features that will attract wildlife. For example, geese are often drawn to turfgrass and the open water commonly found on golf courses (Ayers et al. 2010); but if drainage is contained underground and undesirable turf is selected, their attractions may be minimized.

Aerial view of KSUS with wetland present left of AOA in the 1980s (*left*) replaced by specially drained and irrigated golf course (*right*) (*Source:* KSUS).

of Engineers as well as local and state permits; and may necessitate mitigation of removed wetlands on other property within the same watershed and maintenance of the newly constructed wetland for several years (Dolbeer 2013). The allure of wetlands and marshes can be lessened by reducing available food (e.g., fish, insects, vegetation) and shelter (e.g., tall vegetation) resources in accordance with regulations.

LAKES AND PONDS

Like wetlands and marshes, naturally occurring lakes and ponds can be very attractive to a variety of wildlife including waterfowl, wading birds, fish-eating raptors, and others. Lakes and ponds may also be protected by regulations similar to those for wetlands and marshes. In a study of lake systems, Suter (1994) linked abundance and richness of various bird populations to area, food availability, and shoreline vegetation complexity.

RIVERS AND STREAMS

While rivers and streams tend to attract wildlife in less density than lakes or ponds because of their linear shapes and constant flow, they can still serve as sources of food, water, and shelter. Just as many cities are located near rivers and streams, so too are many airports, which can increase possible

Water Resources—Lakes and Ponds: Orlando International (MCO)

Abundant and productive aquatic habitats on airport property, including the AOA, attract many species of potentially hazardous birds, as well as alligators and otters, especially during naturally occurring fish kills (die-offs). Minimizing aquatic biomass through fish removals, sediment dredging, and aquatic plant removal lessens the severity and duration of these events, consequently reducing strike potential. At Orlando International, fish are removed through electrofishing; and sport fish are relocated to public waters in other parts of the city and state. Dredging is conducted by the airport's maintenance department, using heavy equipment including dozers, hydraulic excavator, and long reach excavator, among others. Aquatic weed control is conducted by herbicide applications and grass carp. Initial investment for fish removal equipment was ~$15,000, and annual aquatic herbicide use is ~$270,000. These biotic removals are a part of the airport's WHMP. State fish and game permits were required for scientific collection and grass carp introduction, and an aquatic applicator license was issued from the Florida Department of Agriculture.

Clockwise: Osprey feeding on fish at MCO; removing fish using electrofishing; releasing grass carp (*Ctenopharyngodon idella*) for vegetation control; and dredging to reduce shallow-growing aquatic vegetation (*Source:* MCO).

Water Resources—Lakes and Ponds: Linn State Technical College (1H3)

The Missouri Department of Transportation (MODOT) uses funds from the FAA to initiate airport improvement projects in Missouri. Each airport must be identified by the FAA National Plan of Integrated Airport Systems, and MODOT is required to do a wildlife habitat assessment and mitigation plan. For example, MODOT has worked with Linn State Technical College in Linn on a plan to remove ponds adjacent to a small airport owned by the college that attract potentially hazardous waterfowl. While MODOT does not do the actual modifications itself, it uses funding from FAA grants to pay for the work, and helps plan and organize the projects. MODOT will often provide such funding for installation of fencing to exclude wildlife from airport property as well.

Pond adjacent to Linn State Technical College Airport (1H3) planned to be removed (*Credit:* MODOT).

conflicts with wildlife using these waterways (Figure 9). Streams commonly attract waterfowl and shorebirds, but often birds will remain over or near the water. Streams are protected by federal and state environmental regulations that may limit management strategies. Reducing the attractiveness of vegetation adjacent to streams may be an effective approach to reducing the attractiveness of streams themselves.

STORMWATER IMPOUNDMENTS

Aircraft safety is the number one concern at an airport, and FAA guidance on controlling stormwater aims to remove water from hard surfaces quickly (within 48 hours) to reduce risk to aircraft. However, stormwater can often be detained or retained to reduce erosion and allow settlement and management

FIGURE 9 PDX is located along the Columbia River near the confluence with the Willamette River (*Source:* Port of Portland).

FIGURE 10 Water retention pond at PDX before and after installation of floating cover (i.e., bird balls; *Source:* Port of Portland). An impervious membrane was installed to maintain a water depth of 5–6 ft.

of potential pollutants, according to the U.S. Clean Water Act (FAA 2006) and various local and state regulations. Standing bodies of water are major lures to potentially hazardous wildlife, including ducks and geese. Human-made ponds and other detention and retention water control structures often require modifications, such as restrictive fencing, overhead wiring, sloped banks, or complete surface covers (e.g., netting or floating balls; Figure 10) to eliminate attraction of waterfowl and other wildlife (Blackwell et al. 2013). However, such remedies may require frequent maintenance or replacement to remain effective.

Tenant facilities on property surrounding airports can be a potential hazard if wildlife are induced to enter or cross over the AOA. Birds flying toward or away from a tenant stormwater facility adjacent to an airport can be serious hazards to aircraft safety. While the FAA (2007) recommends maintaining a five-mile buffer between the AOA and a wildlife attractant, this is often not the case. Airport officials may need to work with local officials to mitigate the risk of attracting wildlife across airport property. The appeal of these facilities can be reduced by using designs that limit the surface area and perimeter of the water, and reducing the vegetation and grass area that surrounds retention ponds that may attract geese (Blackwell et al. 2013; Fox 2013).

PONDING

Pavement

Impermeable pavement can cause puddling after storm events, which may attract hazardous wildlife (e.g., gulls) to airport property including the AOA. Proper engineering and planning of impermeable areas often includes creating sloping to allow stormwater to flow off pavement to well-drained areas. Depressions in pavement can allow puddling of water after storm events and may require repair to prevent attraction of hazardous wildlife. Earthworms often migrate to pavement

Water Resources—Human-Made: Dallas/Fort Worth International (DFW)

Airports are not extricable from their surroundings, and operations on nearby private property or leased property often present risks. Like many airports, DFW must work with surrounding industries that may affect the safety in its AOA, which in its case include drilling for natural gas. These operations require retention of water used during rock fracturing that contains other substances regulated for environmental quality. These open surface waters also attract potentially hazardous wildlife, mostly birds and mammals. The operators of the drilling operations have cooperated with the airport, and taken several measures to reduce wildlife use, including fencing, use of impermeable substrates to reduce vegetation growth, installation of overhead cables, and construction of steep slopes and walls to prevent wading near or out of the ponds. These combined efforts have been effective at reducing use by most species of concern. While retention or detention of water may be necessary for stormwater and wastewater management, proper planning, design, and cooperation can reduce risks of attracting hazardous wildlife.

Techniques to reduce use of retention ponds by wildlife can include installing overhead cables (*top left*), fencing and impermeable substrates (*top right*), and steep walls and banks (*bottom left*) (*Source:* DFW).

after heavy storms that drive them from saturated soils onto hard surfaces, and may then also attract worm-eating birds.

Porous pavement is an open-graded mix placed in a manner that results in a substantial space between rocks, producing a high volume of absorption or storage within the voids, and infiltration to subsoils (Tokunaga and Wan 1997). The pavement might be permeable concrete or asphalt, a manufactured systems such as interlocking brick, or a combination of sand and brick lattice. At airports, porous pavement is suitable for passenger parking areas or infrequently-used service

Water Resources—Human-Made: Port of Portland (PDX)

Access to all parts of airport property is important for effective and efficient wildlife management. Airport operators in parts of the world where rain is common may have trouble accessing saturated parts of the AOA. At PDX, operators were limited by the lack of roads across saturated areas of turfgrass in parts of the AOA, preventing them from reaching areas necessary for aviation wildlife hazing. Planners and engineers decided to use asphalt millings to build roads through these often saturated areas. Proper design allowed these roads to shed water and avert ponding, while allowing access to more of the AOA for aviation wildlife management.

Installing roads out of asphalt millings with impervious membrane at PDX (*left*) allowed greater access to the AOA for wildlife management operations (*right*) (*Source:* Port of Portland).

roads. Concerns with weight-bearing capacity (FAA 2009) generally preclude its use where aircraft are maneuvering or parking, such as runways, taxiways, and clearways. In cold weather climates, the use of porous pavement in areas where grit is applied for traction, such as on parking lots, can result in pore clogging, standing water, or icy conditions.

Permeable Surfaces

Some airports use permeable materials such as gravel or asphalt millings for road surfaces. However, these surfaces can become clogged with dirt or grit over time, resulting in reduced permeability. Proper planning, engineering, and maintenance of roads with permeable surfaces can reduce formation of depressions that retain stormwater.

SLOPE

When rain falls on impervious surfaces, it forms a layer of water that flows and becomes deeper as it approaches the edge and meets an outlet or permeable surface. Not only can this create an enticement to hazardous wildlife, it can also produce hazardous conditions for moving vehicles and may delay water removal from surfaces where puddles are likely to form. To prevent these hazards, the FAA recommends slopes for effective flow of water from the crown of a paved surface to the edge where an open permeable surface is located to then further drain the water (FAA AC 150/5320-5C). The adjacent permeable area can also allow surface flows with adequate slope leading to a drainage control system.

Slope is also an important aspect of ditches and water holding bodies. Some airport operators have reported that ditches with steeper slopes are less attractive to wildlife because they present greater difficulty of walking up and down the slopes, and reduced visibility for awareness of predators (Figure 11). This is similarly effective in retention and detention ponds which, if constructed with a

FIGURE 11 Ditches with steep slopes are less attractive to many wildlife species (*Credit:* A. Johnson).

steep hard edge above the water level, are difficult for wading birds to use for foraging; and hinder waterfowl in climbing out of the water (see previous case example).

DRAINAGE

Surface Materials

Many airports are restricted as to the amount of impervious surface they have on their property, in an effort to reduce high-flow storm events washing nutrients, sediments, and pollutants into nearby waterways (AC 150/5300-13). Airport operators should therefore be creative and judicious about where impermeable surfaces are necessary and where they might instead use soil, turf, or other permeable materials (DeVault et al. 2013). Each of these surface materials will create different potential attractants to various wildlife species. Some airports have had success in reusing the asphalt millings from resurfacing projects on runways for new roadways or to replace turf or vegetation that had been attracting potentially hazardous wildlife. To maximize drainage of surfaces, operators can consider soil type, slope, vegetation cover, etc. that will affect the rate of permeation or drainage of water (Fredlund et al. 1994).

Drainage Systems

Alternative control techniques are available for managing stormwater that may not require a deep standing body of surface water. Higgins and Liner (2007) describe subsurface flow wetlands (SSFW; Figure 12) as insulated, aerated, easy to operate, and relatively inexpensive compared to traditional ponding facilities. SSFW are areas where stormwater runoff is directed into vegetated areas of well-drained soil or gravel with a slight slope. These areas may be lined with an impermeable liner to prevent chemicals in runoff from leaching into ground water. After biodegradation and sedimentation of the detained water, it may evaporate or flow out of the vegetated area on the down slope. And because SSFW are underground, they do not attract wildlife as a surface water facility would. However, SSFW facilities tend to be large, to allow quick infiltration of shallow areas, which can lead to problems in freezing conditions. An alternative that Higgins and Liner proposed was engineered wetlands—vegetated gravel beds that allow quick infiltration and insulation to prevent freezing. Additionally, the vegetation is expected to absorb nutrients and other pollutants from runoff.

Additional drainage techniques include best management practices known as low impact development (Dietz 2007; Davis 2008; Dietz and Clausen 2008) or green infrastructure (Washington Department of Transportation 2009); Oregon Department of Environmental Quality 2011a). These

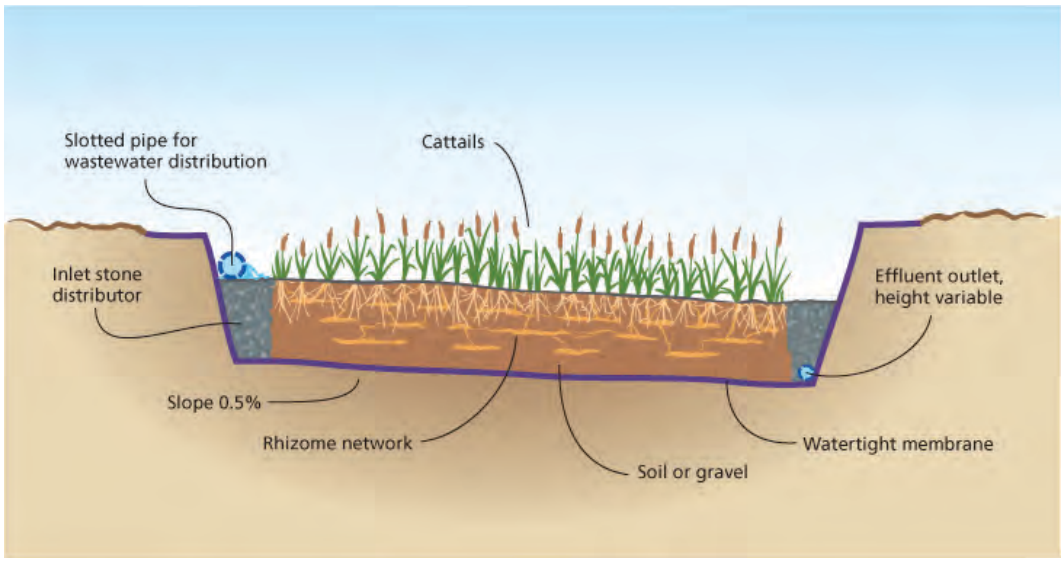


FIGURE 12 Example of a subsurface flow wetland (SSFW; *Credit:* University of California).

techniques focus on use of natural or manufactured systems that use infiltration, evaporation, and reuse of rainwater to remove or control stormwater. Some of the specific infiltration techniques include reducing impermeable surfaces and retaining natural areas that allow rainwater infiltration; and installing specially designed infiltration areas such as gardens, trenches, and porous pavement. Grass swales and filtration strips along impervious surfaces may also be alternatives to retention facilities. However, these more natural infiltration areas may attract wildlife if they harbor such attractants as insects, worms, and vegetation. An evaluation of airport drainage systems in North Carolina led to the replacement of most surface water ponds with filtration strips and vegetated areas. Barrels and cisterns can also be used to control stormwater, collecting water to be used later for washing, landscaping, etc., without allowing access by wildlife. Stormwater permits for airports now require incorporation of low-impact development and green infrastructure techniques (Oregon Department of Environmental Quality 2011b, ACRP 09-08).

All drainage systems will require maintenance and eventual replacement. Sedimentary buildup or clogging require relatively routine maintenance, but eventual degradation of concrete and metal structures will lead to the need to replace systems if they are inadequate or fail to properly remove stormwater.

Water Resources—Drainage: North Carolina

North Carolina has 72 publicly owned and operated airports across the state, each with a unique set of wildlife hazard issues. However, one common issue is stormwater retention and detention ponds near runways that attract waterfowl. Information from North Carolina airports suggested high use by Canada geese on and near airports in the state. As was described in the section on stormwater, open ponds or other forms of stormwater control devices are often required in construction projects. In 2011, the North Carolina Department of Transportation's Division of Aviation, along with the stormwater permitting agency [North Carolina Department of Environment and Natural Resources-Division of Water Quality (DWQ)] and other state agency and university investigators began to examine the issue of stormwater devices attracting hazardous wildlife. Shortly after, a bill was passed ordering a formal investigation by DWQ of the stormwater management requirements for the state. This led to new legislation changing the requirements for open surface stormwater retention or detention ponds, allowing alternative methods within five miles of an airport AOA, such as grassed buffers, shoulders, and grass swales. These areas are much less attractive to the target hazardous wildlife, especially resident Canada geese. This allowed a change in the DWQ best management practices and recommended stormwater management around airports. The permitting for the alternative methods will still be reviewed and issued by DWQ, but it now has a much more effective set of tools to address a common wildlife-hazards issue.

Water Resources—Drainage: North Carolina *(Continued)*

Retention ponds near airports (*left*) can now be replaced by adequate infiltration areas (*right*) (*Source:* NCDOT).

CHAPTER NINE

PERMITTING CONCERNS

FAA Part 139 requires an inspection, typically annually, of the AOA to check for presence of wildlife. In addition to meeting FAA standards, airport operators must meet all local, state, and federal requirements for land development and habitat manipulation. Issues such as stormwater control, wetland mitigation, and management of habitat protected for threatened and endangered species face regulatory oversight and often require legal attention to maintain compliance. Advance communication among local, state, and federal officials, airport operators, and knowledgeable wildlife biologists can prevent most regulatory infractions and develop a professional working relationship helpful in handling future issues. For example, a qualified airport wildlife biologist will be able to help determine how new stormwater structures and management practices might influence attraction of wildlife.

LOCAL

Cities and municipalities often have regulations and zoning laws restricting use of natural resources such as water, and may also limit amounts of impervious surfaces to help reduce stormwater runoff. Airport operators can work with local officials to meet these regulations and take such restrictions into consideration when developing a wildlife hazard management plan. Changes in habitat or landscaping in order to ensure aviation safety may be necessary after initial airport design and construction. By developing a working relationship with local officials who know the laws and regulations, airport operators can be better prepared for limitations on plans for habitat and resource management.

STATE

Every state and province in North America is faced with a unique set of issues regarding wildlife hazards to aviation safety. Depending on the species involved, airport operators will have to determine methods of insuring aviation safety while navigating their state's laws and regulations (CertAlert No. 06-07). State agencies most commonly involved with airport wildlife and habitat management are those which oversee wildlife, fisheries, and other natural resources; and those in charge of environmental quality. Operators can consult and cooperate with state biologists in meeting regulations and restrictions regarding modification of habitat, and harassment or removal of wildlife. One generalization for habitat management to reduce attraction of wildlife is not to improve or increase habitat on or near airport property. Operators can also be prepared to adapt their management strategies, including changes in policy and funding, to meet all rules and regulations. Some states may have standing depredation orders that allow the taking of wildlife on airports if the species is not protected by state or federal regulations regarding threatened and endangered wildlife. (An example depredation order for wildlife at airports from Florida is reproduced in Appendix F.)

FEDERAL

While the FAA has criteria for reducing wildlife hazards on and around airport property, operators will also need to obtain federal permits and approval for some habitat manipulations. For example, changes to wetlands often involve permits and delineations from the U.S. Army Corps of Engineers under Section 404 of the Clean Water Act. State agencies often have parallel wetland-fill regulations requiring state permitting and mitigation for impacts to wetlands in addition to the federal requirements

TABLE 1
LIST OF FAA DOCUMENTS RELATED TO WILDLIFE MANAGEMENT AT AIRPORTS

Document Type	Reference Number	Title
Advisory Circular	150/5300-13	Airport Design
Advisory Circular	150/5200-32	Reporting Wildlife Aircraft Strikes
Advisory Circular	150/5200-33	Hazardous Wildlife Attractants on or Near Airports
Advisory Circular	150/5200-36	Qualifications for Wildlife Biologists Conducting Wildlife Hazard Assessments and Training Curriculums for Airport Personnel Involved in Controlling Wildlife Hazards on Airports
CertAlert	98-05	Grasses Attractive to Hazardous Wildlife
CertAlert	04-09	The Relationship between FAA and USDA/WS
CertAlert	04-16	Deer Hazards to Aviation and Deer Fencing
CertAlert	06-07	Requests by State Wildlife Agencies to Facilitate and Encourage Habitat for State-Listed Threatened and Endangered Species and Species of Special Concern on Airports
CertAlert	09-10	Wildlife Hazard Assessments in Accordance with Part 139 Requirements

(see Table 1). In addition, protected species, such as migratory birds, and threatened and endangered species are afforded special immunity, often forbidding destruction of their preferred habitat (http://www.fws.gov/migratorybirds/RegulationsandPolicies.html). If these species are attracted to airport habitat, even if it is unintentional or temporary, operators may have to take actions to protect them from harm. Airports can often obtain a depredation permit for migratory birds from the U.S. Fish and Wildlife Service (Appendix B). A standing depredation order exists for protection from damage by several types of blackbirds and seasonally for Canada geese; a state depredation permit may also be required or state law may restrict take beyond federal restrictions (Cleary and Dickey 2010). One unique example of a specific federal regulation affecting only two species is the Bald and Golden Eagle Act (Code of Federal Regulations 2012), which prohibits anyone from taking, possessing, or transporting parts, eggs, or nests of bald or golden eagles without prior authorization.

Copies of FAA Advisory Circulars, CertAlerts, and related documents can be downloaded free of charge at:

http://www.faa.gov/airports/resources/publications/
http://www.faa.gov/airports/resources/advisory_circulars/
http://www.faa.gov/airports/airport_safety/certalerts/

The FAA Wildlife Strike Database is available at:

http://wildlife.faa.gov/public_html/index.html
http://wildlife.pr.erau.edu/

Permitting—Federal: Port of Portland (PDX)

Portland International used dredge material to fill an extensive wetland area next to the runway on airport property, unintentionally creating an attractant to a federally-designated threatened species, the streaked horned lark (*Eremophila alpestris strigata*). The dredge material and some other areas of the airport now used by the lark were proposed for designation as critical habitat and protection under the Endangered Species Act. However, under Section 4(b)(2) of that legislation, the U.S. Fish and Wildlife Service (USFWS) has exempted Portland and other non-federal airports from designation of critical habitat protection to ensure human safety through management aviation properties. Larks have been documented to be at risk of mortality from aircraft collisions, and thus a hazard at airports; FAA regulations require airports to take immediate action to alleviate wildlife hazards whenever they are detected. However, the requirement to maintain airfields free of wildlife hazards would severely limit the potential to increase streaked horned lark populations, and combined with the threat of aircraft strikes and the need for constant management to minimize bird populations, it is clear that airports do not provide ideal conditions for the long-term conservation of the streaked horned lark. Although airports currently support some of the largest populations of streaked horned larks, the USFWS recognizes and concurs with the statement from one rule peer reviewer that "bird conservation is not and should not be a desired component of airport management." USFWS acknowledges that airports provide transitory suitable habitat for the subspecies, but has no intention of encouraging an increase in populations of streaked horned larks on airports as part of their long-term recovery strategy.

Proposed critical habitat area designation at PDX (*left,* inside red line) for the streaked horned lark (*right*) (*Source:* Port of Portland).

CHAPTER TEN

OTHER POTENTIAL CONFLICTS

Wildlife management in the airport environment is often complex. Operators are expected to maintain the aesthetic appeal and safe functionality of airport property, while minimizing potential wildlife hazards. This may involve nearly constant patrolling for wildlife posing risks to aircraft operation safety, or extensive and complicated habitat manipulations involving years of work and permitting. Local, state, and federal levels of regulations must all be met for habitat management or direct actions against wildlife to take place. Airport operators are under added pressure to reduce their impact on the environment and to use more energy-efficient technologies and designs. Wildlife management is essentially an attempt to control nature, which is an extremely difficult task. Changes in habitats, surrounding environments, weather, and regulations can all affect how operators best approach wildlife management challenges and how effective current management techniques will be.

SOCIAL

Economic Considerations

If managed correctly, wildlife can in some cases be sources of income for airports; however, in all cases, airport operators need to ensure potential sources of income do not increase hazards. Some airport properties contain areas that are safe for recreational hunting. Airports that own large areas of woodland outside of a protective perimeter fence may be able to lease hunting opportunities, which would further benefit the airport by adding population control on species such as deer. A similar system may work in wetland areas that attract waterfowl; however, concerns have been raised that bird hunting adjacent to airports may attract more waterfowl to the area because of the use of decoys and calls (DeVault et al. 2013).

Airports can also make money from selling crops or leasing parts of their property for agriculture. While many agricultural operations attract potentially hazardous wildlife, some, such as hay production, may be safe if separated from the AOA. Also, livestock grazing may be safe and profitable—again, if the wildlife are excluded from the AOA. Operators can determine what land use practices are appropriate for their region and potentially hazardous wildlife species present. Land uses that do not attract wildlife may vary depending on region, surrounding habitat, and time of year.

Airports often occupy large parcels of land that are able to support other profitable operations such as solar, wind, and biofuel production; when energy demands for airport operations are low, power production by solar and wind may produce excess energy that can then be sold back to the local power provider (DeVault et al. 2012). Also, biofuels can be produced and sold like hay or other agricultural crops (Martin et al. 2013). Airports can also lease excess property to industrial developers or for parking for patrons other than those using the airport, for example, for sporting events. One important consideration about any construction or development project is that changes to the land, even clearing to bare ground, may create a new habitat appealing to wildlife of certain species. Operators can prepare for the possibility of new hazards as development moves from phase to phase, and may need to adapt their management and hazard prevention methods accordingly.

Financial Sustainability

Wildlife management can be expensive, especially as airports are required to reduce wildlife-strike risks; so determining the most effective and efficient methods for meeting these safety obligations

is in an airport's best interests (AC 150/5300-13). Reducing resources suitable for wildlife use will reduce the need for wildlife management (Dickey and Cleary 2010). Many habitat manipulations and wildlife management techniques may be very simple, and operators can learn from peers what to try before spending time and money on unproven approaches to a given problem. However, what works for one airport will not work for all of them. Considerations for implementing a habitat management strategy include airports' unique habitat, potential wildlife hazards, and relevant regulations. Incorporation of green technologies such as solar and wind are also potential methods of reducing costs.

ECOLOGICAL

While the needs for animal survival—food, water, and shelter—may appear simple, the complexities of ecological systems can become overwhelming when people attempt to control them. Some ecosystems may contain numerous wildlife species that in some way contribute to a single human–wildlife conflict. In most cases it would be impossible, impractical, or unnecessary to remove all of these species to solve the problem. Understanding ecological complexities is part of finding the most reasonable approach to resolving a conflict. Operators can study the needs of the wildlife they want to manage and how the airport environment provides at least one of those necessary resources. Also, an airport may just be located between two necessary resources, and using the airspace or travel corridor between these resources is the only reason an animal is found in or near an airport. Thus, airports are part of a larger landscape with a multitude of relationships between wildlife and habitat. In order to minimize aircraft–wildlife hazards, operators can learn to manage their airport space and its role in the surrounding environment.

Other Issues—Ecological: Southeast, U.S.

An airport in the southeast is located along the Intracoastal Waterway, which is a major haven for many species of wading birds, shore birds, and birds of prey. Large natural areas like this pose unique management challenges because they cannot be removed, and widespread control efforts would involve multiple agencies or landowners. In this case, the airport was forced to reduce the attractiveness of its property to deter potentially hazardous wildlife as much as possible, but was unable to remove the major attractant.

Southeastern U.S. airport next to the Intracoastal Waterway.

CHAPTER ELEVEN

CONCLUSIONS AND FURTHER RESEARCH

This synthesis has described many potential attractants to hazardous wildlife on and around airports and provided examples of methods for reducing the risk caused by these habitat features. It is important to keep in mind the unique situation of each airport and the management techniques that can best be integrated into an inclusive and adaptive plan for addressing wildlife hazards. Working closely with engineers, planners, biologists, landscapers, and maintenance staff will help airport operators charged with minimizing wildlife hazards understand the various issues.

Further, each habitat management approach can be evaluated for effectiveness as well as dollar value. Some control techniques may be very simple and inexpensive, and can be tried before using more complex solutions; integrating these methods may have improved effect, and habitat management may enhance them even further by making certain areas and resources less suitable or attractive. It may help if operators keep in mind that most wildlife attractants are related to food, water, or cover, and may be easily removed without damaging airport functionality. However, the complexities of wildlife ecology can make it difficult to completely eliminate a conflict with wildlife. Many species can be persistent and may adapt to changes in habitat, while other species may take advantage of beneficial changes in habitat.

Airports often cover relatively large areas of open space and may include or be surrounded by several different habitat types (e.g., grasslands, pavement, forest, agriculture). This diversity of habitats may attract a variety of wildlife species with a unique resource needs and preferences. Not all of these species will pose a risk to aircraft safety, and the airport environment may have a positive impact on conservation of non-hazardous species, including some that are threatened or endangered. Local, state, and federal policies and laws may limit the control techniques that are allowed, from stormwater management to removal of wetlands or extirpation of protected wildlife. Acquiring permits can be the most difficult part of habitat management, and it helps if operators are prepared for political or public criticism of their management strategies, including the removal of resources that attract wildlife.

Numerous case examples at airports and a synthesis of much of the scientific literature on wildlife habitat management at airports were provided here. However, what works best for controlling a wildlife problem at one airport may not be effective for the same wildlife species or hazardous situation elsewhere. There remains much to learn about how best to manage airport habitats to reduce suitability for wildlife species considered hazardous to aircraft, including identifying additional turfgrass species less appealing to wildlife; reducing wildlife-attracting agricultural operations; modifying or eliminating platform and perching structures on airport property; and developing more methods of controlling stormwater to reduce attractive surface water.

ACRONYMS AND FEATURED AIRPORTS

AC	Advisory Circular
AOA	Aircraft Operations Area
BOS	Logan International
DFW	Dallas–Fort Worth International
DWQ	Department of Water Quality
ESA	Endangered Species Act
EWR	Newark Liberty International
FAT	Fresno–Yosemite International
GNV	Gainesville Regional
GKY	Arlington Municipal
GSO	Piedmont–Triad International
HNL	Honolulu International
ICAO	International Civil Aviation Organization
JFK	John F. Kennedy International
KCI	Kansas City International
KSUS	Spirit of St. Louis
LAL	Lakeland Linder Regional
MCO	Orlando International
MODOT	Missouri Department of Transportation
NCDOT	North Carolina Department of Transportation
ODEQ	Oregon Department of Environmental Quality
ORD	Chicago O'Hare International
PDX	Portland International
SEA	Seattle–Tacoma International
SLC	Salt Lake City International
SSFW	Subsurface Flow Wetland
USDA	U.S. Department of Agriculture
VCT	Victoria Regional
VOR	Very High Frequency Omnidirectional Range Navigation System
WHMP	Wildlife Hazard Management Plan

GLOSSARY

A

Aircraft operations area (AOA)—Any area of an airport used or intended to be used for landing, takeoff, or surface maneuvering of aircraft. An aircraft 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.

B

Bird balls—High-density plastic floating balls that can be used to cover ponds and prevent birds from using the sites.

Bird strike—See Wildlife strike.

C

Control technique—Any design regulation, management effort, or change to a habitat feature intended to reduce attraction of wildlife.

Cover—Vegetation over a ground surface serving as shelter for wildlife that are 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).

Dredge spoil containment areas—Dredge spoil is the material removed during dredging operations intended to help keep harbors or boat channels open when they become silted due to river or tidal actions. Dredge spoil containment areas are areas where dredge material is disposed of or stored.

E

Endophyte—A symbiotic organism, usually a bacterium or fungus, that lives within a plant without causing apparent damage. Endophytes can benefit host plants by preventing pathogens from colonizing and increase plant growth.

Extirpation—Removal or extinction of a species from a specific area or portion of its range.

G

Granivorous—A diet consisting mostly of grain seeds.

H

Habitat—Collection of environmental features, man-made structures, and natural resources.

Hazardous wildlife—Species of wildlife (birds, mammals, reptiles, insects, earthworms), 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 (AC 150/5200-33, Hazardous Wildlife Attractants on or near Airports; 14 CFR 139.3).

Herbivore—An animal whose diet consists mostly of plant matter.

L

Loafing—Wildlife that are "loafing" are simply hanging around until it is time to look for food or a place to roost.

M

Migratory bird—"[A]ny 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 greylag 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.

P

Passerine—A bird in the order Passeriformes, which includes perching birds and songbirds.

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, 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 birds to rest and sleep. Roosting birds often collect in large numbers. Pigeons, starlings, and blackbirds are the most commonly seen roosting birds.

W

Wastewater treatment facility—Any devices or systems used to store, treat, recycle, or reclaim municipal sewage or liquid industrial wastes, including Publicly Owned Treatment Works (POTW), as defined by Section 212 of the Federal Water Pollution Control Act (PL 92-500) as amended by the Clean Water Act of 1977 (PL 95-576) and the Water Quality Act of 1937 (PL 100-4). This definition includes any pretreatment involving the reduction of the amount of pollutants, the elimination of pollutants, or the alteration of the nature of pollutant properties in wastewater prior to or in lieu of discharging or otherwise introducing such pollutants into a POTW [40 CFR 404.3 (o), (p), (q)].

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, AOA, 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 Hazard Assessment (WHA)—An evaluation of wildlife-related attractants and potential hazards to aircraft operations, often mandated by the FAA following a hazardous event or new potential threat.

Wildlife Hazard Management Plan (WHMP)—When a hazardous event occurs or threat arises, the FAA may require airport operations to conduct a WHA. The WHA may determine that a personalized plan is needed for preventing and addressing specific wildlife threats for that airport. This is the WHMP and includes procedures and standard operating procedures for minimizing wildlife-related hazards at an airport.

Wildlife strike—A wildlife strike has occurred when:

- A pilot reports striking one or more birds or other wildlife;
- Aircraft maintenance personnel identify aircraft damage as having been caused by a wildlife strike;
- Personnel on the ground report seeing an aircraft strike one or more birds or other wildlife;
- 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
- The animal's presence on the airport had a significant negative effect on a flight (i.e., aborted takeoff, aborted landing, high-speed emergency stop, aircraft left pavement area to avoid collision with animal) (criteria 1–4 adopted from Transport Canada 2002).

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APPENDIX A

QUESTIONNAIRE FOR GATHERING INFORMATION FROM AIRPORTS FOR CASE STUDIES ON SPECIFIC WILDLIFE ATTRACTANTS

AIRPORT COOPERATIVE RESEARCH PROGRAM SYNTHESIS S13-10-10

HABITAT MANAGEMENT TO DETER WILDLIFE AT AIRPORTS

QUESTIONNAIRE

Your help with the synthesis of wildlife habitat management topics at airports is appreciated. Please consider this questionnaire referring to a single topic attractant or technique for controlling that attractant. Feel free to fill out multiple questionnaires if several topics apply to your airport or airports that you work with. Information you provide will be summarized into a case example to be included into a management guide by the Transportation Research Board. It is not necessary to answer all questions–please provide as much information as is available. If you would like the airport and airport personnel to remain anonymous in the case example please indicate so below. Please return this file with your comments and answers to cayers@cfr.msstate.edu. Thank you again for your consideration and cooperation.

Information

Airport name: Airport location:

Respondent's name: Respondent's e-mail:

Would you like this case example to remain anonymous?

Description

Please briefly describe the wildlife attractant or control technique:

Please answer the following questions if relevant to your attractant or control technique.

Potential Wildlife Attractant

Does this attractant exist on or off airport property?

Was this attractant an unintentional development from airport design or naturally occurring?

How long after airport opening did this attractant become evident or develop?

Can the attractant be removed without changing airport function?

What wildlife species were attracted to this habitat feature?

How much money has been spent on or what is the cost of wildlife deterrence from this attractant (Total if problem is solved, annually if chronic issue)?

How much money has been spent on or what is the cost of modification or removal of this attractant?

Control Technique

What attractant or hazard was this technique intended to prevent or reduce?

Was this technique an original part of airport design or installed after for prevention or attention to a recognized potential attractant or hazard?

How much money has been spent on or what is the cost of this technique?

Was this technique effective?

How was this technique's effectiveness measured?

Would you use this technique again?

What do you think could have been an alternative approach to using this technique?

What were any permitting issues involved with using this technique?

What wildlife species did this technique target, work for, and not work for and how was this determined?

Photos

Are photos available of this attractant and/or control technique and may they be used with photographer credit? If so, please attach them as separate files with your response e-mail.

APPENDIX B

FAA AIRPORTS DIVISION, HEADQUARTERS, AND REGIONAL OFFICES; U.S. FISH AND WILDLIFE SERVICE REGIONAL OFFICES; AND U.S. DEPARTMENT OF AGRICULTURE, WILDLIFE SERVICES, HEADQUARTERS, AND STATE OFFICES

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

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 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 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 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 Great Lakes Region Headquarters Serving: IL, IN, MI, MN, OH, ND, SD, WI
Federal Aviation Administration
Great Lakes Region
O'Hare Lake Office Center
2300 East Devon Avenue
Des Plaines, IL 60018
Tel. (847) 294-7294, Fax (847) 294-7036

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 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 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 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 Western Pacific Region Headquarters Serving: AZ, CA, GU, HI, NV
Federal Aviation Administration
Western-Pacific Region
15000 Aviation Blvd.
Lawndale, CA 90261
Tel. (310) 725-3550, Fax (808) 541-3462

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

Region 1 (Serving: HI, ID, OR, WA)
911 N.E. 11th Avenue
Portland, OR 97232-4181
Tel. (503) 872-2715, Fax (503) 231-2019

Region 2 (Serving: AZ, NM, OK, TX)
P.O. Box 709
Albuquerque, NM 87103
Tel. (505) 248-7882, Fax (505) 248-7885

Region 3 (Serving: IA, IL, IN, MN, MO, MI, OH, WI)
5600 America Boulevard West, Suite 990
Bloomington, MN 55437-1458
Tel. (612) 713-5436, Fax (612) 713-5393

Region 4 (Serving: AL, AR, FL, GA, KY, LA, MS, NC, SC, TN, VI, PR)
P.O. Box 49208
Atlanta, GA 30359
Tel. (404) 679-7070, Fax (404) 679-4180

Region 5 (Serving: CT, DC, DE, ME, MD, MA, NH, NJ, NY, PA, RI, VA, VT, WV)
P.O. Box 779
Hadley, MA 01035-0779
Tel. (413) 253-8643, Fax (413) 253-8424

Region 6 (Serving: CO, KS, MT, ND, NE, SD, UT, WY)
P.O. Box 25486, DFC (60154)
Denver, CO 80225-0486
Tel. (303) 236-8171, Fax (303) 236-8017

Region 7 (Serving: AK)
1011 E. Tudor Road, MS-201
Anchorage, AK 99503
Tel. (907) 786-3693, Fax (907) 786-3641

Region 8 (Serving: CA, NV)
2800 Cottage Way
Sacramento, CA 95825
Tel. (916) 978-6183, Fax (916) 414-6486

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

Headquarters
U.S. Department of Agriculture
Animal and Plant Health Inspection Service
Wildlife Services
Room 1624 South Agriculture Building
Washington, DC 20250-3402

Mailing address:
USDA/APHIS/WS STOP 3402
Washington, DC 20250-3402

Operational Support Staff
USDA/APHIS/WS
Operational Support Staff
4700 River Road, Unit 87, Room 2D26
Riverdale, MD 20737-1234

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

Eastern Region (Serving: AL, AR, CT, DE, DC, FL, GA, IL, IN, IA, KY, LA, ME, MD, MA, MI, MS, MO, NH, NJ, NY, NC, OH, PA, PR, RI, SC, TN, VT, VI, VA, WV, WI)
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 University
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
720 O'Leary Street NW
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
State Director
12345 W. Alameda Pkwy., Suite 204
Lakewood, CO 80228
Tel. (303) 236-5810, Fax (303) 236-5821

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

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

District of Columbia Fisheries and Wildlife Division

Florida

FAA Southern Region
USFWS Region 4
USDA Eastern Region
USDA State Office
State Director
2820 E. University Ave.
Gainesville, FL 32641
Tel. (352) 377-5556, Fax (352) 377-5559

Florida Department of Environmental Protection
Florida Fish and Wildlife Commission

Georgia

FAA Southern Region
USFWS Region 4
USDA Eastern Region
USDA State Office
State Director
School of Forestry and Natural Resources
University of Georgia
Athens, GA 30602
Tel. (706) 546-5637, Fax (706) 316-9248

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)
State Director
3375 Kaopaka Street, Suite H-420
Honolulu, HI 96819
Tel. (808) 838-2841, Fax (808) 838-2860

Government of Guam Agencies

Hawaii

FAA Western Pacific Region
USFWS Region 1
USDA Western Region
USDA State Office
State Director
3375 Kaopaka Street, Suite H-420
Honolulu, HI 96819
Tel. (808) 838-2841, Fax (808) 838-2860

Hawaii Department of Land and Natural Resources
Hawaii Division of Aquatic Resources
Hawaii Division of Forestry and Wildlife

Idaho

FAA Northwest Mountain Region
USFWS Region 1
USDA Western Region
USDA State Office
State Director
9134 W. Blackeagle Drive
Boise, ID 83709-1572
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Idaho Department of Fish and Game
Idaho Division of Environmental Quality

Illinois

FAA Great Lakes Region
USFWS Region 3
USDA Eastern Region
USDA State Office
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2869 Via Verde Dr.
Springfield, IL 62703
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Illinois Department of Natural Resources
Illinois Environmental Protection Agency

Indiana

FAA Great Lakes Region
USFWS Region 3
USDA Eastern Region
USDA State Office
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Purdue University, Smith Hall
901 W. State Street
W. Lafayette, IN 47907
Tel. (765) 494-6229, Fax (765) 494-9475

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
Tel. (573) 449-3033, Fax (573) 449-4382

Iowa Department of Natural Resources

Kansas

FAA Central Region
USFWS Region 6
USDA Eastern Region
USDA State Office
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4070 Ft. Riley Boulevard
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)
State Director
537 Myatt Drive
Madison, TN 37115
Tel. (615) 736-5506, Fax (615) 736-2768

Kentucky Department for Environmental Protection
Kentucky Department of Fish and Wildlife Resources

Louisiana

FAA Southwest Region
USFWS Region 4
USDA Eastern Region
USDA State Office
State Director
P.O. Box 589
Port Allen, LA 70767
Tel. (225) 389-0229, Fax (225) 389-0228

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
State Director
79 Leighton Rd, Suite 12
Augusta, ME 04330
Tel. (207) 629-5181, Fax (207) 629-5182

Maine Department of Conservation
Maine Department of Environmental Protection
Maine Department of Inland Fisheries and Wildlife

Maryland

FAA Eastern Region
USFWS Region 5
USDA Eastern Region
USDA State Office
State Director
1568 Whitehall Road
Annapolis, MD 21401
Tel. (410) 349-8055, Fax (410) 349-8258

Maryland Department of the Environment
Maryland Department of Natural Resources

Massachusetts

FAA New England Region
USFWS Region 5
USDA Eastern Region
USDA State Office
State Director
463 West Street
Amherst, MA 01002
Tel. (413) 253-2403, Fax (413) 253-7577

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
USDA Eastern Region
USDA State Office
State Director
2803 Jolly Road, Suite 160
Okemos, MI 48864
Tel. (517) 336-1928, Fax (517) 336-1934

Michigan Department of Environmental Quality
Michigan Department of Natural Resources

Minnesota

FAA Great Lakes Region
USFWS Region 3
USDA Eastern Region
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
Minnesota Pollution Control Agency

Mississippi

FAA Southern Region
USFWS Region 4
USDA Eastern Region
USDA State Office
State Director
P.O. Drawer FW, 200 Thompson Hall
Mississippi State, MS 39762
Tel. (662) 325-3014, Fax (662) 325-3690

Mississippi Department of Environmental Quality
Mississippi Department of Wildlife, Fisheries and Parks

Missouri

FAA Central Region
USFWS Region 3
USDA Eastern Region
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Columbia, MO 65202
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Missouri Department of Conservation
Missouri Department of Natural Resources

Montana

FAA Northwest Mountain Region
USFWS Region 6
USDA Western Region
USDA State Office
State Director
P.O. Box 1938
Billings, MT 59103
Tel. (406) 657-6464, Fax (406) 657-6110

Montana Department of Environmental Quality
Montana Fish, Wildlife and Parks
Montana Department of Natural Resources and Conservation

Nebraska

FAA Central Region
USFWS Region 6
USDA Eastern Region
USDA State Office
State Director
5940 S. 58th Street
Lincoln, NE 68516
Tel. (402) 434-2340, Fax (402) 434-2339

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
USDA State Office
State Director
8775 Technology Drive
Reno, NV 89521
Tel. (775) 851-4848, Fax (775) 851-4828

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
Tel. (518) 477-4837, Fax (518) 477-4899

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
Tel. (505) 346-2640, Fax (505) 346-2627

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
State Director
6213-E. Angus Drive
Raleigh, NC 27617
Tel. (919) 786-4480, Fax (919) 782-4159

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
State Director
2110 Miriam Circle, Suite A
Bismarck, 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 University
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 University
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 C

U.S. FISH AND WILDLIFE SERVICE MIGRATORY BIRD REGIONAL PERMIT OFFICES

USFWS	AREA OF	MAILING	CONTACT
Region 1	**Hawaii, Idaho, Oregon, Washington**	911 N.E. 11th Avenue Portland, OR 97232-4181	Tel. (503) 872-2715 Fax (503) 231-2019 E-mail: 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 E-mail: 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 E-mail: 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 E-mail: 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 E-mail: 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 E-mail: permitsR6MB@fws.gov
Region 7	**Alaska**	1011 E. Tudor Road (MS-201) Anchorage, AK 99503	Tel. (907) 786-3693 Fax (907) 786-3641 E-mail: permitsR7MB@fws.gov
Region 8	**California, Nevada**	2800 Cottage Way Sacramento, CA 95825	Tel. (916) 978-6183 Fax (916) 414-6486 E-mail: permitsR8MB@fws.gov

APPENDIX D

RELATIVE VALUES OF PLANTS TO WILDLIFE IN FLORIDA

Common Name	Scientific Name	Perching/ Roosting/ Nesting	Mast Production	Insects
Trees				
Pines	Pinus (sand pine is much less valuable to wildlife than others)	High	High in fall – birds and squirrels	Low
Oaks	Quercus (most valuable are water, live, and laurel)	High	High in fall – birds, squirrels, deer, hogs	Moderate
White ash	Fraxinus americana	Moderate	Low	Moderate
Swamp ashes	Fraxinus spp.	Moderate	Low	Low
Elms	Ulmus spp.	Moderate	Low	Low
River birch	Betula	Moderate	Low	Low
Tupelo	Nyssa	Moderate	Moderate in summer and fall - mammals	Low
Red cedar	Juniperus virginiana	Moderate	Moderate – winter birds	Low
Black cherry	Prunus serotina	High	High – summer birds; all year sapsuckers	Moderate
Laurelcherry	Prunus caroliniana	Low	Low	Low
Bradford pear	Pyrus	Low	Low	Low
Crepe myrtle	Lagerstroemia	Low	Low	Low
Bald cypress	Taxodium	High	Low	Moderate
Dogwood	Cornus	Moderate	Moderate – some winter birds	Low
Hercules club	Zanthozylum	Low	Low	Low
Hickory	Carya spp.	High	High in fall - mammals	High
Pecan	Carya illinoinensis	Moderate	High in fall - mammals	High
Holly	Ilex	Moderate	High in winter – birds; low rest of year	Low
Jerusalem thorn	Parkinsonia	Low	Low	Low
Loquat	Eriobotrya	Moderate	High in summer – birds and mammals	Moderate
Magnolia	Magnolia	Moderate	Low	Moderate
Maple	Acer	Moderate	High in spring – birds and squirrels	Moderate
Persimmon	Diospyros	Moderate	High in fall – mammals; low rest of year	Moderate
Plum; peach	Prunus spp.	Low	High in summer – mammals	Moderate
Redbud	Cercis	Low	Low	Low
Sugarberry	Celtis	High	High in fall - birds	Moderate

Common Name	Scientific Name	Perching/ Roosting/ Nesting	Mast Production	Insects
Sweetgum	Liquidambar	Moderate	Moderate - sapsuckers	Moderate
Willow	Salix spp.	High (usually a problem because of location next to water)	Low	Low
Weeping willow	Salix babylonica	Low	Low	Low
Sabal palm	Sabal	Low	High – birds and all mammals year round	High, especially if palms retain boots to the ground
Date palms	Phoenix	Low	Moderate - birds	Moderate
Chinese fan palm	Livistona	Low	Moderate - birds	Moderate
European fan palm	Chamaerops	Low	Moderate - birds	Moderate
Royal palm	Roystonea	Low	Moderate – birds and mammals	Low
Pindo palm	Butia	Low	Moderate – birds and mammals	Moderate
Queen palm	Syagrus	Low	Moderate – birds and mammals	Low

Common Name	Scientific Name	Denning/ Nesting/ Cover	Mast Production	Insects
Shrubs				
Sago	Cycas	Low	Low	Low
Saw palmetto	Serenoa	Low	High – birds and mammals	High
Anise	Illicium	Low	Low	Low
Arbor-vitae	Platycladus	Moderate	Low	Low
Azalea	Rhododendron	Low	Low	Low
Blueberry	Vaccinium	Low	High in summer – birds and mammals	Low
Blackberry	Rubus	High	High in summer – birds and mammals	High
Wax myrtle	Myrica	High	Moderate in winter - birds	Moderate
Camellia	Camellia	Low	Low	Low
Coontie	Zamia	Moderate	Low	Low
Elderberry	Sambucus	High – birds may roost in taller ones	High in summer – birds and mammals	Moderate
Gallberry	Ilex glabra	High	Low	High
Juniper	Juniperus chinensis	Moderate	Low	Low
Indian hawthorn	Raphiolepis	Moderate	Moderate – deer eat leaves	Low
Hibiscus	Hibiscus rosa-sinensis	Low	Low	Low
Burford holly	Ilex cornuta	Moderate	Moderate in winter - birds	Moderate
Shellings holly	Ilex "shellings"	Moderate	Low	Low
Fetterbush	Lyonia	Moderate	Low	Moderate
Oleander	Nerium	Low	Low	Low
Tree philodendron	Philodendron selloum	Low	Low	Low
Red-tip	Photinia	Moderate	Low	Moderate
Japanese yew	Podocarpus	Moderate	Low	Moderate
Silverthorn	Elaeagnus	Moderate	Low	Moderate
Sweet olive	Osmanthus	Moderate	Low	Low
Thyrallis	Galphimia	Low	Low	Low
Viburnum	Viburnum spp.	Moderate	Moderate in summer - birds	Moderate

APPENDIX E

LIST OF PLANTS WITH LOW ATTRACTION TO WILDLIFE IN OHIO

GRASSES		
SPECIES	COMMON NAME	MAX HEIGHT in Feet
Hakonechloa macra 'Aureola'	Golden Variegated Hakonechloa	8 inch
Pennisetum alopecuroides 'Little Bunny'	Little Bunny Fountain Grass	8-10 inch
Arrhenatherum bulbosum 'Variegatum'	Variegated Oat Grass	1
Festuca glauca	Blue Fescue	1
Molinia caerulea 'Variegata'	Variegated Purple Moor Grass	1-2
Pennisetum alopecuroides 'Moudry'	Black Fountain Grass	1-2
Pennisetum orientale	Oriental Fountain Grass	1-2
Phalaris arundinacea var. picta	Ribbon Grass	1-3
Hordeum jubatum	Foxtail Barley	2
Carex elata 'Bowles Golden'	Bowles Golden Sedge	2-3
Leymus arenarius	Blue Lyme Grass	2-3
Miscanthus sinensis 'Adagio'	Adagio Miscanthus	2-3
Imperata cylindrica var. rubra 'Red Baron'	Red Baron Japanese Bloodgrass	2-4
Molinia caerulea ssp. arundinacea 'Skyracer'	Skyracer Tall Moor Grass	2-4
Acorus calamus 'Variegatus'	Variegated Sweet Flag	3
Helictotrichon sempervirens	Blue Oat Grass	3
Pennisetum alopecuroides 'Hameln'	Dwarf Fountain Grass	3
Miscanthus sinensis var. purpurascens	Flame Grass	3-4
Miscanthus sinensis 'Yaku Jima'	Yaku Shima Miscanthus	3-4
Panicum virgatum 'Rotstrahlbusch'	Rotstrahlbusch Switchgrass	3-4
Pennisetum alopecuroides	Fountain Grass	3-4
Calamagrostis acutiflora	Feather Reed Grass	3-5
Calamagrostis acutiflora 'Karl Foerster'	Karl Foerster Feather Reed Grass	3-5
Panicum virgatum 'Heavy Metal'	Heavy Metal Switchgrass	3-6
Spodiopogon sibiricus	Frost Grass	4
Miscanthus sinensis 'Gracillimus'	Gracillimus Miscanthus	4-6
Miscanthus sinensis 'Variegatus'	Variegated Miscanthus	4-6
Panicum virgatum 'Dallas Blues'	Dallas Blues Switchgrass	5
Sorghastrum nutans 'Sioux Blue'	Sioux Blue Indian Grass	5
Miscanthus sinensis 'Graziella'	Graziella Miscanthus	5-6
Miscanthus sinensis 'Morning Light'	Morning Light Miscanthus	5-6
Miscanthus sinensis 'Silberpfeil'	Silver Arrow Miscanthus	5-7
Miscanthus sinensis 'Cosmopolitan'	Cosmopolitan Miscanthus	6
Panicum virgatum	Switchgrass	6
Miscanthus sinensis 'Zebrinus'	Zebra Grass	6-7
Miscanthus sinensis 'Strictus'	Porcupine Grass	6-8
Arundo donax 'Variegata'	Variegated Giant Reed Grass	6-12
Saccharum ravennae	Ravenna Grass	6-12
Miscanthus sinensis 'Cabaret'	Cabaret Miscanthus	7
Miscanthus sinensis 'Rotsilber'	Rotsilber Miscanthus	7
Pleioblastus auricomus	Variegated Bamboo	7
Miscanthus sinensis 'Grosse Fontane'	Grosse Fontane Miscanthus	7-8
Arundo donax	Giant Reed Grass	12
Miscanthus floridulus	Giant Chinese Silver Grass	12

SHRUBS		
SPECIES	COMMON NAME	MAX HEIGHT in Feet
Buxus sinica var. insularis 'Tide Hill'	Tide Hill Korean Boxwood	1
Forsythia viridissima 'Bronxensis'	Bronx Forsythia	1-1.5
Lonicera xylosteum	Fly Honeysuckle	1-8
Lonicera xylosteum 'Emerald Mound'	Emerald Mound Fly Honeysuckle	1-8
Buxus microphylla var. koreana 'Winter Gem'	Winter Gem Boxwood	2
Deutzia gracilis	Slender Deutzia	2
Spiraea x bumalda 'Goldflame'	Goldflame Spirea	2
Spiraea 'Goldmound'	Goldmound Spirea	2
Buxus 'Green Velvet'	Green Velvet Boxwood	2-3
Euonymus fortunei 'Emerald Gaiety'	Emerald Gaiety Euonymus	2-4
Euonymus fortunei 'Emerald 'n Gold'	Emerald 'n Gold Euonymus	2-4
Euonymus fortunei 'Green Lane'	Green Lane Euonymus	2-4
Spiraea x bumalda 'Anthony Waterer'	Anthony Waterer Spirea	2-4
Buxus sinica var. insularis 'Winter Beauty'	Winter Beauty Korean Boxwood	3
Caryopteris x clandonensis 'Blue Mist'	Blue Mist Spirea	3
Deutzia gracilis 'Nikko'	Nikko Slender Deutzia	3
Deutzia scabra 'Pink Pompom'	Pink Pompom Fuzzy Deutzia	3
Fothergilla gardenii	Dwarf Fothergilla	3
Hypericum patulum	Goldencup St. Johnswort	3
Potentilla fruticosa 'Abbotswood'	Abbotswood Bush Cinquefoil	3
Potentilla fruticosa 'Goldfinger'	Goldfinger Bush Cinquefoil	3
Rhododendron 'Herbert'	Herbert Azalea	3
Spiraea betulifolia 'Tor'	Tor Spirea	3
Spiraea x bumalda	Bumald Spirea	3
Weigela florida 'Variegata'	Variegated Weigela	3
Spiraea japonica 'Little Princess'	Little Princess Japanese Spirea	3
Philadelphus 'Miniature Snowflake'	Miniature Snowflake Mockorange	3-4
Daphne x burkwoodii 'Carol Mackie'	Carol Mackie Daphne	4
Rhododendron 'Golden Lights'	Golden Lights Azalea	4
Rhododendron 'P.J.M.'	PJM Rhododendron	4
Spiraea japonica	Japanese Spirea	4
Spiraea japonica 'Shirobana'	Shirobana Japanese Spirea	4
Weigela florida 'Java Red'	Java Red Old Fashioned Weigela	4
Buxus 'Green Mountain'	Green Mountain Boxwood	4-5
Syringa patula 'Miss Kim'	Miss Kim Lilac	4-9
Abelia 'Edward Goucher'	Edward Goucher Abelia	5
Hydrangea arborescens 'Annabelle'	Annabelle Hydrangea	5
Hydrangea macrophylla 'Forever Pink'	Forever Pink Bigleaf Hydrangea	5
Hydrangea macrophylla 'Glowing Embers'	Glowing Embers Bigleaf Hydrangea	5
Hydrangea macrophylla 'Nikko Blue'	Nikko Blue Bigleaf Hydrangea	5
Hydrangea macrophylla 'Tokyo Delight'	Tokyo Delight Bigleaf Hydrangea	5
Hydrangea macrophylla 'Variegata'	Variegated Bigleaf Hydrangea	5
Kerria japonica	Japanese Kerria	5
Kerria japonica 'Picta'	Variegated Japanese Kerria	5

(*continued on next page*)

SHRUBS		
SPECIES	COMMON NAME	MAX HEIGHT in Feet
Kerria japonica 'Pleniflora'	Doubleflowering Japanese Kerria	5
Pieris floribunda	Mountain Pieris	5
Rhododendron 'Mary Belle'	Mary Belle Rhododendron	5
Rhododendron 'Stewartstown'	Stewartstown Azalea	5
Rhododendron 'Thomas Jefferson'	Thomas Jefferson Azalea	5
Spiraea x cinerea 'Grefsheim'	Grefsheim Spirea	5
Spiraea nipponica 'Snowmound'	Snowmound Nippon Spirea	5
Spiraea x bumalda 'Froebelii'	Froebelii Bumald Spirea	5
Weigela 'Newport Red'	Newport Red Weigela	5
Weigela 'Red Prince'	Red Prince Weigela	5
Abelia x grandiflora	Glossy Abelia	6
Cytisus scoparius 'Moonlight'	Moonlight Scotch Broom	6
Itea virginica	Virginia Sweetspire	6
Itea virginica 'Henry's Garnet'	Henry's Garnet Virginia Sweetspire	6
Syringa meyeri	Meyer Lilac	6
Weigela Briant Rubidor®	Briant Rubidor™ Weigela	6
Ceanothus x pallidus 'Marie Simon'	Marie Simon Ceanothus	6-8
Fothergilla major 'Mt. Airy'	Mt. Airy Fothergilla	6-8
Weigela florida	Old Fashioned Weigela	6-9
Rhododendron catawbiense	Catawba Rhododendron	6-10
Rhododendron yakushimanum 'Yaku Queen'	Yaku Queen Rhododendron	6-10
Hydrangea quercifolia	Oakleaf Hydrangea	7
Hydrangea quercifolia 'Snow Queen'	Snow Queen Oakleaf Hydrangea	7
Weigela 'Bristol Ruby'	Bristol Ruby Weigela	7
Buddleia davidii	Butterfly Bush	8
Buddleia davidii 'Harlequin'	Harlequin Butterfly Bush	8
Buddleia davidii var. nanhoensis Petite Plum®	Petite Plum™ Butterfly Bush	8
Buddleia davidii 'Pink Delight'	Pink Delight Butterfly Bush	8
Buddleia davidii 'White Profusion'	White Profusion Butterfly Bush	8
Buddleia x weyeriana 'Sungold'	Sungold Butterfly Bush	8
Calycanthus floridus	Common Sweetshrub	8
Euonymus alatus 'Compactus'	Compact Burning Bush	8
Forsythia x intermedia	Border Forsythia	8
Forsythia x intermedia 'Spring Glory'	Spring Glory Border Forsythia	8
Hamamelis vernalis	Vernal Witchhazel	8
Hibiscus syriacus	Rose-of-Sharon	8
Hibiscus syriacus 'Aphrodite'	Aphrodite Rose-of-Sharon	8
Hibiscus syriacus 'Blue Bird'	Blue Bird Rose-of-Sharon	8
Hibiscus syriacus 'Diana'	Diana Rose-of-Sharon	8
Hydrangea paniculata	Panicle Hydrangea	8
Hydrangea paniculata 'Grandiflora'	P.G. Panicle Hydrangea	8
Hydrangea paniculata 'Tardiva'	Tardiva Panicle Hydrangea	8
Lonicera fragrantissima	Winter Honeysuckle	8
Rhododendron 'Rosy Lights'	Rosy Lights Azalea	8

SHRUBS		
SPECIES	COMMON NAME	MAX HEIGHT in Feet
Syringa x prestoniae 'Minuet'	Minuet Preston Lilac	8-12
Cephalanthus occidentalis	Buttonbush	10
Corylus avellana 'Contorta'	Harry Lauder's Walkingstick	10
Kolkwitzia amabilis	Beautybush	10
Pieris japonica	Japanese Pieris	10
Pieris japonica 'Mountain Fire'	Mountain Fire Japanese Pieris	10
Pieris japonica 'Scarlett O'Hara'	Scarlett O'Hara Japanese Pieris	10
Pieris japonica 'Valley Valentine'	Valley Valentine Japanese Pieris	10
Syringa vulgaris	Common Lilac	10
Syringa vulgaris 'Sensation'	Sensation Common Lilac	10
Syringa x chinensis	Chinese Lilac	10
Euonymus alatus	Burning Bush	10-15
Euonymus japonicus 'Aureus'	Golden Japanese Euonymus	10-15
Acer tataricum ssp. ginnala 'Flame'	Flame Amur Maple	10-20
Cotinus coggygria	Common Smokebush	12
Cotinus coggygria 'Velvet Cloak'	Velvet Cloak Smokebush	12
Kalmia latifolia	Mountain-laurel	12
Ligustrum obtusifolium var. regelianum	Regel Border Privet	12
Corylus cornuta	Beaked Filbert	14
Corylus maxima	Giant Filbert	15
Corylus maxima 'Purpurea'	Purple Giant Filbert	15
Magnolia stellata	Star Magnolia	15
Caragana arborescens 'Pendula'	Weeping Siberian Peashrub	18
Hamamelis virginiana	Common Witchhazel	18
Hamamelis x intermedia 'Arnold Promise'	Arnold Promise Witchhazel	20
Acer campestre 'Compactum'	Compact Hedge Maple	30
Parrotia persica	Persian Parrotia	30
Aesculus parviflora	Bottlebrush Buckeye	80

TREES		
SPECIES	COMMON NAME	MAX HEIGHT in Feet
Acer palmatum 'Crimson Queen'	Crimson Queen Japanese Maple	8-10
Acer palmatum var. dissectum atropurpureum	Red Cutleaf Japanese Maple	10
Betula pendula 'Youngii'	Youngii Weeping Birch	10-12
Franklinia alatamaha	Franklin Tree	10-12
Staphylea trifolia	American Bladdernut	10-15
Acer platanoides 'Globosum'	Globe Norway Maple	15
Cercis canadensis	Redbud	15
Cercis canadensis 'Alba'	White Redbud	15
Laburnum x watereri	Goldenchain Tree	15
Acer tataricum	Tatarian Maple	15-20+
Cercidiphyllum japonicum 'Pendula'	Weeping Katsura Tree	15-25
Acer palmatum 'Bloodgood'	Bloodgood Japanese Maple	16-20
Acer griseum	Paperbark Maple	20
Acer palmatum	Japanese Maple	20
Acer truncatum ssp. mono	Painted Maple	20
Acer tataricum ssp. ginnala	Amur Maple	20
Cercis canadensis 'Forest Pansy'	Forest Pansy Redbud	20-30
Betula populifolia	Gray Birch	20-40
Acer cissifolium	Ivy-leaved Maple	25
Acer japonicum	Fullmoon Maple	25
Carpinus caroliniana	American Hornbeam	25
Magnolia x soulangiana	Saucer Magnolia	25
Oxydendrum arboreum	Sourwood	25
Syringa reticulata	Japanese Tree Lilac	25
Acer buergeranum	Trident Maple	25-35
Carpinus betulus 'Fastigiata'	Upright European Hornbeam	25-40
Acer campestre	Hedge Maple	30
Halesia tetraptera	Carolina Silverbell	30
Stewartia	Stewartia	30
Stewartia koreana	Korean Stewartia	30
Acer saccharum 'Sweet Shadow'	Sweet Shadow Sugar Maple	30-50
Acer platanoides 'Green Lace'	Green Lace Norway Maple	35
Catalpa bignonioides	Southern Catalpa	35
Betula papyrifera	Paper Birch	40
Betula utilis var. jacquemontii	Whitebarked Himalayan Birch	40
Carpinus betulus	European Hornbeam	40
Phellodendron amurense	Amur Corktree	40
Betula pendula	European White Birch	45
Acer rubrum October Glory™	October Glory® Red Maple	40-50
Acer rubrum Red Sunset™	Red Sunset® Red Maple	40-50
Alnus glutinosa 'Pyramidalis'	Columnar Common Alder	40-50
Betula nigra Heritage™	Heritage® River Birch	40-50
Betula platyphylla var. japonica 'Whitespire'	Whitespire Birch	40-50
Cladrastis kentukea	American Yellowwood	40-50
Acer platanoides 'Summershade'	Summershade Norway Maple	40-60
Acer pseudoplatanus 'Atropurpureum'	Atropurpureum Sycamore Maple	40-60
Acer x freemanii	Freeman Maple	40-60
Cercidiphyllum japonicum	Katsura Tree	40-60
Tilia cordata	Littleleaf Linden	40-60

TREES		
SPECIES	COMMON NAME	MAX HEIGHT in Feet
Halesia monticola	Mountain Silverbell	40-80
Halesia monticola 'Rosea'	Rosea Mountain Silverbell	40-80
Acer negundo	Boxelder	50
Acer platanoides	Norway Maple	50
Acer platanoides 'Cleveland'	Cleveland Norway Maple	50
Acer platanoides 'Crimson King'	Crimson King Norway Maple	50
Acer platanoides 'Drummondi'	Variegated Norway Maple	50
Acer pseudoplatanus	Sycamore Maple	50
Acer rubrum 'Columnare'	Columnar Red Maple	50
Acer saccharum 'Monumentale'	Monument Sugar Maple	50
Carpinus betulus 'Columnaris'	Columnar European Hornbeam	50
Eucommia ulmoides	Hardy Rubber Tree	50
Fraxinus pennsylvanica	Green Ash	50
Robinia pseudoacacia	Black Locust	50
Ulmus parvifolia	Lacebark Elm	50
Ulmus 'Urban'	Urban Elm	50
Acer rubrum 'Autumn Flame'	Autumn Flame Red Maple	50-60
Acer saccharum Green Mountain"	Green Mountain® Sugar Maple	50-75
Fraxinus americana Skyline"	Skyline® White Ash	50-80
Acer platanoides 'Erectum'	Upright Norway Maple	60
Acer saccharinum	Silver Maple	60
Acer saccharum	Sugar Maple	60
Alnus glutinosa	Common Alder	60
Betula nigra	River Birch	60
Catalpa speciosa	Northern Catalpa	60
Gleditsia triacanthos var. inermis	Thornless Common Honeylocust	60
Gleditsia triacanthos var. inermis 'Sunburst'	Sunburst Thornless Common Honeylocust	60
Liquidambar styraciflua	Sweetgum	60
Liquidambar styraciflua 'Rotundiloba'	Round-lobed Sweetgum	60
Liquidambar styraciflua 'Variegata'	Variegated Sweetgum	60
Zelkova serrata	Japanese Zelkova	60
Acer platanoides 'Schwedleri'	Schwedler Norway Maple	65
Acer platanoides 'Emerald Queen'	Emerald Queen Norway Maple	60-70
Acer pseudoplatanus 'Redroyal'	Redroyal Sycamore Maple	60-70
Acer rubrum	Red Maple	70
Acer saccharinum 'Beebe'	Beebe Cutleaf Silver Maple	70
Acer saccharinum 'Laciniatum'	Cutleaf Silver Maple	70
Fraxinus americana	White Ash	70
Gymnocladus dioica	Kentucky Coffeetree	70
Metasequoia glyptostroboides	Dawn Redwood	70
Taxodium distichum	Bald Cypress	70
Larix decidua	European Larch	75
Acer nigrum	Black Maple	70-110
Ginkgo biloba	Ginkgo	80
Platanus	Planetree	80
Platanus occidentalis	American Planetree	80
Platanus x acerifolia	London Planetree	80
Betula maximowicziana x spp.	Hybrid Monarch Birch	80-100

APPENDIX F

DEPREDATION ORDER FOR WILDLIFE AT AIRPORTS IN FLORIDA

68A-9.012 Take of Wildlife on Airport Property.
Any airport may take wildlife on airport property for the purpose of ensuring aircraft and human safety in accordance with this rule. An airport or other entity owning or operating an airport as defined in Section 330.27(2), F.S., or their officers, employees, contractors (or employee of a contractor) or member of the airport's governing body as referenced in Section 379.2293(5), F.S., may carry out the activities specified in this rule. Notwithstanding the provisions of this section, the executive director or a designee may issue permits authorizing the take of additional species of wildlife, additional methods of take or alternative forms of disposition and transportation for justifiable purposes pursuant to Rule 68A-9.002, F.A.C., provided authorizations shall be denied or revoked upon reasonable conclusion that the requested or permitted activity would be detrimental to fish and wildlife resources or public health and safety.

(1) The taking and disposition of species regulated by the United States Departments of Interior or Commerce in 50 C.F.R. §10.13 (Migratory Birds), 50 C.F.R. § 17.11 and §17.12 (Threatened and Endangered Species), 50 C.F.R. §22 (Bald Eagle), 50 C.F.R. §223.102 and §224.102 (Marine Species), is allowed pursuant to federal authorization. No additional Commission authorization is required.

(2) The following paragraphs control the take of black bears and species described in Chapter 68A-27, F.A.C., except species described in subsection (1):
   (a) Any of these species may be harassed by persistent, non-injurious disturbance without physical capture or direct handling to disperse wildlife when the wildlife poses an imminent threat to aircraft and human safety.
   (b) Any of these species may be otherwise taken when:
      1. The wildlife poses an imminent threat to aircraft and human safety; and
      2. A situation requires an emergency response which does not allow time for paragraph (2)(a); or
      3. Attempts using paragraph (2)(a) have been documented as unsuccessful and when:
         a. The airport is implementing a Federal Aviation Administration approved wildlife hazard management plan; and
         b. The airport has made habitat management alteration that has eliminated or significantly reduced hazardous wildlife attractants on airport property.
   (c) Wildlife burrows, including gopher tortoise burrows, within the safety area as defined in 14 C.F.R. § 139.5 may be destroyed after or while all existing gopher tortoise(s) within the burrows are live captured.

(3) Notwithstanding any provision of Commission rule, an airport authority may take all other wildlife not described in subsections (1) and (2) on airport property if their presence poses a potential threat to aircraft and human safety.

(4) Notwithstanding any provision of Commission rule, wildlife in subsections (2) and (3) taken pursuant to this rule may be taken by any method except the following:
   (a) Poison, other than those pesticides that are registered by the Florida Department of Agriculture and Consumer Services without additional authorizations and are only used in a manner consistent with the product labeling.
   (b) Leg hold traps except those commercially manufactured padded-jaw traps.
   (c) Traps, nets and snares unless they are visited at intervals not exceeding 24 hours.
   (d) Any method prohibited pursuant to Section 828.12, F.S.
   (e) Live capture of any deer, except Key deer as authorized by subsection (1).
   (f) The killing of gopher tortoises is prohibited.

(5) Disposition of live-captured wildlife.
   (a) Any species described in subsection (2) live captured shall be immediately released provided the release site and capture site are located on a contiguous piece of airport property or a permit or authorization has been obtained from the Commission for off-site release or alternative forms of disposition.
   (b) Any species described in subsection (3) live captured by any method shall be released or euthanized within 24 hours following capture or inspection of a trapping device containing wildlife except,
      1. Wildlife may only be released if:
         a. The wildlife is released on the property of the airport provided the release site and capture site are located on a contiguous piece of property; or
         b. The wildlife is a native species; and
         c. The property where the animal is to be released is located within the county of capture and is a minimum of 40 contiguous acres; and
         d. The person releasing the wildlife is in possession, at time of release, of written permission from the property owner allowing such action.
      2. Euthanasia of wildlife shall be humane as defined by the American Association of Zoo Veterinarians or the American Veterinary Medical Association.
      3. Euthanasia of any live captured bobcat is prohibited and any live captured bobcat shall be released as provided in subparagraph 1.

(6) Transportation of wildlife.
  (a) Live-captured wildlife described in subsection (3), may be transported pursuant to this subsection only for:
    1. The purpose of euthanasia as provided in subsection (5); or
    2. The purpose of release as provided in subsection (5).
  (b) Transportation of wildlife authorized by this subsection shall not supersede the provisions of any rabies alert or area quarantine issued by County Health Departments or County Animal Services.
(7) Wildlife described in subsections (2) and (3) that is killed pursuant to this rule or parts of that wildlife shall not be retained for personal use and shall be buried or incinerated.
(8) Any take that kills wildlife described in subsection (2) shall be reported by the airport. An Airport Wildlife Incident Report (Form FWC-AWIR 06-2010, herein incorporated by reference) must be submitted to the Commission within 5 business days. The form is available at MyFWC.com and must be submitted to the Protected Species Permit Coordinator, 620 S. Meridian Street, Mail Station 2A, Tallahassee, FL 32399-1600 or by e-mail at AirportIncidents@myFWC.com.

Rulemaking Authority Art. IV, Sec. 9, Fla. Const. Law Implemented Art. IV, Sec. 9, Fla. Const. History–New 7-27-10.

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
HMCRP	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