Applying an SMS Approach to Wildlife Hazard Management

DETAILS

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AIRPORT COOPERATIVE RESEARCH PROGRAM

ACRP REPORT 145

Applying an SMS Approach to Wildlife Hazard Management

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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.

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The research team comprised Dr. Russell DeFusco, Principal Investigator and Qualified Airport Wildlife Biologist; Dr. Edward Unangst, Jr., Program Manager and Qualified Airport Wildlife Biologist; Dr. Timothy Cooley, Computer Engineering Modeler; and Ms. Joanne M. Landry, Safety Management Systems Technical Expert. The team was awarded the project and began work in January 2014.

FOREWORD

By Theresia H. Schatz
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ACRP Report 145 introduces and guides the application of a risk-based approach to wildlife hazard management (WHM) programs and outlines additional steps for integrating such programs into an airport's Safety Management System (SMS). This guidance includes a description of an SMS approach to WHM and includes a glossary of key terms; a listing of relevant resources and databases; an overview description of four components of SMS; a comparison of current WHM standards to those used in SMS; a description of innovative protocols and procedures—in narrative and visual formats—for developing WHM programs in the style of SMS; and applicability to airports of various sizes and operations regardless of SMS implementation, wildlife program, or Part 139 certification. This report also provides a customizable tool—the Wildlife Hazard Management Risk Assessment Tool (WHaMRAT)—and templates that are usable for assessing wildlife risk at airports. The tool includes a resource summary of existing database wildlife hazard descriptions; numerical values for hazard severity and likelihood by species, derived from the FAA Wildlife Strike Database; and a practical, simplified electronic or manual risk analysis template, which includes the incorporation of variables on or off the airport.

The presence of wildlife near airports is a safety issue and carries with it growing economic losses in the aviation industry. Airports may soon be required to adopt a proactive risk-based approach like an SMS to manage many operational aspects of the airport business, including wildlife.

The applicability and efficacy of utilizing data-driven, risk-based methodologies for wildlife management have been debated due to the highly variable nature of wildlife presence related to various species, size, flocking and movement patterns, season, time of day, region, disturbances in the vicinity of airports, and other related factors. To date, little guidance was available on how to apply SMS principles to WHM programs at airports of various sizes and operations.

Under ACRP Project 04-17, research was conducted by BASH Incorporated in association with TEWS Incorporated, DynamX Consulting, and Landry Consultants LLC. A gap analysis for wildlife management and SMS was conducted at a variety of airports that had current SMS projects, Wildlife Hazard Assessments (WHAs), or Wildlife Hazard Management Plans (WHMPs). Criteria were used that determined if candidate airports had the necessary information, involvement in SMS, or wildlife hazards that would allow the research team to use such airports in their model development and/or model test. Development of the tool (WHaMRAT) was based on input from the participating airport surveys and the experience and expertise of the research team.

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Note: Photographs, figures, and tables in this report may 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.

CHAPTER 1

Introduction and Project Overview

1.1 Background

ACRP Report 145 is based on the research conducted in ACRP Project 04-17, "Applying an SMS Approach to Wildlife Hazard Management." Wildlife presence at airports and the associated potential for wildlife strikes with aircraft is a significant safety concern that carries with it growing economic losses in the aviation industry. Airports may soon be required to adopt a Safety Management System (SMS), which is a proactive, risk-based approach to manage many operational aspects of the airport business, including wildlife.

The applicability and efficacy of using risk-based methodologies for wildlife management and control have been debated given the highly variable nature of wildlife presence related to various species, size, behavior, flocking and movement patterns, plus the variability associated with season, time of day, region, disturbances in the vicinity of airports, and other related factors. To date, little guidance has been available regarding how to develop SMS-style wildlife management and control programs that can be applied universally across all airports. However, wildlife management programs fit perfectly with SMS principles. Known risks are associated with hazardous wildlife; data are normally collected as part of wildlife management programs; outcomes are measurable and empirical in nature; and wildlife management program goals such as continuous improvement through trending and data analysis can be incorporated directly into an airport's SMS.

1.2 Objective

The objective of ACRP Project 04-17 was to develop a document to introduce and guide the application of a risk-based approach to wildlife hazard management (WHM) programs and outline additional steps for integrating such programs into an SMS for airports and stakeholders. Requirements for the guide included:

- A description of an SMS approach to WHM.
  - A glossary of key terms.
  - A listing of relevant resources and databases.
  - An overview description of SMS including all four components of SMS.
  - A comparison of current WHM program standards to those of SMS.
  - A description of innovative protocols and procedures, in narrative or visual formats for developing WHM programs in the style of SMS.
  - Applicability to airports regardless of SMS implementation, wildlife program, or Title 14 Code of Federal Regulations (CFR) Part 139 certification.

- Customizable tool(s) and template(s) that are useful for assessing wildlife risk at airports.
  - A resource summary of existing database wildlife hazard descriptions.
  - Numerical values for severity and likelihood for species derived from the FAA's national Wildlife Strike Database.
  - An electronic or manual risk analysis template, which includes the incorporation of variables on or off the airport.

1.3 Deliverables

The final deliverables for the research project included:

- A guidebook that describes a risk-based approach to WHM programs and outlines steps for integrating such programs into an SMS for airports.
- Customizable tool(s) and template(s) that are useful for assessing wildlife risk at airports.
- A final report that documents the entire research effort, including any assumptions used and the research team's recommendation of research needs and priorities for additional related research.

ACRP Report 145 details WHM and SMS, describes the development of the Wildlife Hazard Management Risk Assessment Tool (WHaMRAT), and provides guidance on the integration of the WHaMRAT into SMS at airports. Readers should be aware that all references to FAA documents, including the Advisory Circulars, were used and cited in their current versions as published at the time this report was prepared. Existing documents and publication of drafts are periodically updated and readers are advised to consult the most current version of these documents for any relevant future changes. For example, at the time of this report, Draft FAA Advisory Circular 150/5200-37A, Safety Management System for Airports, published in June 2012, is undergoing changes; thus, all references to AC 150/5200-37A in this report should be verified in the future.

CHAPTER 2

Wildlife Hazard Management Background

Wildlife risk has been associated with aircraft operations since the dawn of aviation. The threat has only increased over time. For many years, the aviation community has recognized the impact of bird and other wildlife strikes on the safety of aircraft passengers and crew. These hazards have resulted in billions of dollars in direct and indirect costs and, more importantly, caused injuries and fatalities to hundreds of aircrews and passengers in commercial, private, and military aircraft. Having long recognized that wildlife threats to aviation are profound and ever-increasing, both the civil and military aviation communities have increased their efforts to make aviation safety relative to wildlife strikes a priority concern. Increased and dramatic media attention to wildlife strikes with aircraft—like the coverage of the emergency forced landing of US Airways Flight 1549 in the Hudson River on January 15, 2009 after Canada Geese were ingested in both engines of the Airbus 320—has also demonstrated to the public that wildlife strikes are a serious aviation safety issue. Since 1988, wildlife strikes have killed more than 255 people and destroyed more than 243 aircraft globally.

Data compiled by FAA and the United States Department of Agriculture (USDA) from the FAA Wildlife Strike Database suggest that the number of conflicts between wildlife and aircraft has continued to increase since 1990. FAA's database contains records of more than 142,000 reported wildlife strikes between 1990 and 2013. FAA estimates that the database represents only a portion of the actual number of bird strikes that occurred during this period, and estimates that the database includes approximately 39% of the actual number of strikes that have occurred since 2004 and an even smaller percentage for the period from 1990 to 2004 (Dolbeer et al. 2014). Analysis of the data identified several factors that may have contributed to an increased risk trend between wildlife and aviation safety:

- *The use of faster and quieter aircraft.* Commercial air carriers have replaced their older three- or four-engine aircraft fleets with more efficient, faster, and quieter two-engine aircraft. In many cases, birds are less able to detect and avoid newer aircraft using turbofan engines. Also, in the event that wildlife is ingested by aircraft engines, aircraft with two engines may be more vulnerable than earlier aircraft equipped with three or four engines (Dolbeer et al. 2014).
- *Increased air traffic.* The volume of military and civilian air traffic has increased substantially worldwide. Passenger enplanements in the United States increased from approximately 310 million in 1980 to 732 million in 2013, and commercial air traffic increased from approximately 18 million aircraft movements in 1980 to 25 million aircraft movements in 2013 (Dolbeer et al. 2014). The growth in air traffic has increased the risk of potential conflicts between aviation and wildlife.
- *Increased wildlife populations and adaptation to urban areas.* The populations of many wildlife species commonly involved in strikes have increased markedly in the last few decades (Dolbeer et al. 2014). Concurrently, increasing land use developments have decreased the availability of natural or open areas that historically supported these species. In addition,

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the areas that once separated airports and nearby metropolitan areas have decreased in size. As a result, the remaining open space provides habitat, shelter, and feeding areas for greater populations of wildlife.

The following information covering the years 1990–2013 provides a greater understanding of the risk posed by wildlife on aviation safety (Dolbeer et al. 2014):

- The number of strikes annually reported has increased sixfold, from 1,851 in 1990 to a record 11,315 in 2013 (142,603 strikes for 1990–2013), with strikes reported at 1,821 airports.
- The number of U.S. airports with strikes reported increased from 331 in 1990 to a record 649 in 2013. The 649 airports with strikes reported in 2013 comprised 379 airports certificated for passenger service under Part 139 and 270 general aviation (GA) airports.
- Although the number of reported strikes has steadily increased, the number of reported *damaging* strikes has actually declined, from a peak of 764 in 2000 to 601 in 2013. The decline in damaging strikes has been most pronounced for commercial aircraft in the airport environment (i.e., at ≤ 500 feet above ground level [AGL]). Damaging strikes have not declined for GA aircraft.
- A total of 503 species of birds, 42 species of terrestrial mammals, 19 species of bats, and 15 species of reptiles were identified as having been struck by aircraft. Birds were involved in 97.0% of the reported strikes; terrestrial mammals, in 2.2%; bats, in 0.7%; and reptiles, in 0.1%.
- Waterfowl, gulls, and raptors are the species groups of birds with the most damaging strikes; Artiodactyls (mainly deer) and carnivores (mainly coyotes) are the terrestrial mammals with the most damaging strikes. Although the percentage of wildlife strikes with reported damage has averaged 9% for this 24-year period, the number has declined, from 20% in 1990 to 5% in 2013.
- A total of 52% of bird strikes occurred between July and October; 30 percent of deer strikes occurred in October–November. Terrestrial mammals were more likely to be struck at night (64%), whereas birds were struck more often during the day (62%).
- Most wildlife strikes occurred in the immediate airport vicinity during aircraft approach or departure and at altitudes of less than 3,500 feet AGL, with both birds (61%) and terrestrial mammals (64%) more likely to be struck during the aircraft's landing phase (i.e., descent, approach, or landing roll) compared to take-off and climb (35% and 33%, respectively).
- For commercial and GA aircraft, 71% and 74% of bird strikes, respectively, occurred at or below 500 feet AGL. Above 500 feet AGL, the number of strikes declined by 34% for each 1,000-foot gain in altitude for commercial aircraft, and by 43% for GA aircraft. Wildlife strikes occurring above 500 feet were more likely to cause damage than strikes at or below 500 feet.
- A total of 66 strikes resulted in a destroyed aircraft; 42 (64%) of these occurred at GA airports. The annual cost of wildlife strikes to the U.S. civil aviation industry is projected to be a minimum of 117,740 hours of aircraft downtime and $187 million in direct and other monetary losses and may be as high as 588,699 hours of downtime and $937 million in monetary losses. Indirect costs may be much higher.

Overall, the 24 years of wildlife strike data suggest that progress is being made in reducing damaging strikes for commercial aircraft that primarily use Part 139 certificated airports. Management actions to mitigate the wildlife risk have been implemented at many airports since the 1990s. These efforts are likely responsible for the general decline in reported strikes with damage (and a negative effect on flight) from 2000–2013, despite continued increases in the populations of many large bird species. Nonetheless, additional efforts remain necessary to address the goal of reducing wildlife strikes: FAA recommends that current and future management actions at airports be prioritized based on the hazard level of species observed on the airport and in the surrounding airspace. FAA has also prioritized the need to address strikes above 500 feet AGL and the necessity that the general

public and aviation community widen its view of wildlife management to minimize hazardous wildlife attractants within 5 miles of airports.

Federal guidance on wildlife hazards at airports should continue to be reviewed and, where necessary, revised to incorporate new information about wildlife hazards and wildlife strike reporting trends. Lastly, increased reporting of wildlife strikes with details provided on species identification, number of wildlife struck, time, phase of flight, height, distance from airport, and damage costs is desired.

FAA is the agency responsible for setting and enforcing Federal Aviation Regulations (FARs). FAA establishes policies to enhance public safety at airports that hold certificates under FAR Part 139 and at federally obligated airports. Although many GA airports do not hold a Part 139 certificate, they are considered federally obligated airports if they receive federal funds to support airport operations and undertake capital improvements. When an airport accepts funds from FAA-administered airport financial assistance programs, it must agree to certain obligations or assurances. These obligations require the grant recipient to maintain and operate its airport facilities safely, efficiently, and in accordance with specified conditions. FAA has established 37 specific grant assurances to which airport operators must adhere if they are to receive federal funds.

Wildlife hazard management (WHM) is associated with FAA Grant Assurance No. 19 (Operations and Maintenance). Details specific to WHM in FAA Grant Assurance No. 19 are:

19. Operation and Maintenance.

a. The airport and all facilities which are necessary to serve the aeronautical users of the airport, other than facilities owned or controlled by the United States, shall be operated at all times in a safe and serviceable condition and in accordance with the minimum standards as may be required or prescribed by applicable [f]ederal, state and local agencies for maintenance and operation. It will not cause or permit any activity or action thereon which would interfere with its use for airport purposes. It will suitably operate and maintain the airport and all facilities thereon or connected therewith, with due regard to climatic and flood conditions. Any proposal to temporarily close the airport for non-aeronautical purposes must first be approved by the Secretary. In furtherance of this assurance, the sponsor will have in effect arrangements for -
   1) Operating the airport's aeronautical facilities whenever required;
   2) Promptly marking and lighting hazards resulting from airport conditions, including temporary conditions; and
   3) Promptly notifying airmen of any condition affecting aeronautical use of the airport. Nothing contained herein shall be construed to require that the airport be operated for aeronautical use during temporary periods when snow, flood or other climatic conditions interfere with such operation and maintenance. Further, nothing herein shall be construed as requiring the maintenance, repair, restoration, or replacement of any structure or facility which is substantially damaged or destroyed due to an act of God or other condition or circumstance beyond the control of the sponsor.

b. It will suitably operate and maintain noise compatibility program items that it owns or controls upon which [f]ederal funds have been expended (FAA March 2014).

Per FAR Part 139.337b, FAA will require the operator of a federally obligated airport to conduct a Wildlife Hazard Assessment (WHA)—called an "ecological study" in Part 139—and if necessary, to prepare a Wildlife Hazard Management Plan (WHMP) when a "triggering event" occurs on or near the airport. According to the FARs, FAA can require a WHA when:

(1) An air carrier aircraft experiences multiple wildlife strikes;
(2) An air carrier aircraft experiences substantial damage from striking wildlife. As used in this paragraph, substantial damage means damage or structural failure incurred by an aircraft that adversely affects the structural strength, performance, or flight characteristics of the aircraft and that would normally require major repair or replacement of the affected component;
(3) An air carrier aircraft experiences an engine ingestion of wildlife; or
(4) Wildlife of a size, or in numbers, capable of causing an event described in paragraphs (1), (2), or (3) of this section is observed to have access to any airport flight pattern or aircraft movement area (14 CFR § 139.337[b]).

As detailed above and in response to potential wildlife risk to aviation, FAA has established several reporting and management programs to assist in wildlife hazard mitigation. As part of these programs, all U.S. Part 139 certificated airports, and many other airports that accept federal grant assurances, are required to undergo a comprehensive WHA, and most are subsequently required to implement a WHMP that focuses primarily on reactive safety practices such as wildlife harassment, deterrence, exclusion, removal, or lethal measures combined with habitat management. Depending on the perceived magnitude of the problem and the funding available to conduct such studies, FAA may allow some non-certificated airports such as GA facilities to conduct a truncated version of a WHA called a Wildlife Hazard Site Visit (WHSV) even if they have accepted federal grants-in-aid or experienced triggering events. In some circumstances, FAA may request airports that do not meet the above criteria to conduct a WHA or WHSV and implement a WHMP and may provide funding support to conduct these assessments.

In 2013, FAA continued to make progress with their multifaceted approach for mitigating wildlife strikes. FAA reported that 100% of Part 139 airports had completed a WHA, were in the process of conducting a WHA, or had taken a federal grant to conduct a WHA.

As a result of public awareness and FAA programs with emphasis on the issue, wildlife strike reporting continued to increase, especially with GA aircraft, which increased strike reporting by 11% between 2011 and 2012 and 4% between 2012 and 2013. Overall, from 2008 through 2013, GA strike reporting increased 51% (Dolbeer et al. 2014). FAA also continued to provide Airport Improvement Program (AIP) funding to airports to conduct WHAs and develop WHMPs. These efforts have led not only to increased strike reporting from both commercial and GA airports, but also to a decline in damaging strikes. FAA funded and assisted with the development of three new ACRP publications to aid airports with the mitigation of wildlife hazards: (1) *ACRP Synthesis 39: Airport Wildlife Population Management* (DeFusco and Unangst 2013); (2) *ACRP Synthesis 52: Habitat Management to Deter Wildlife at Airports* (Belant and Ayers 2014); and (3) *ACRP Report 125: Balancing Airport Stormwater and Bird Hazard Management* (Allerton et al. 2015). These reports supplement the previously released *ACRP Report 32: Guidebook for Addressing Aircraft/Wildlife Hazards at General Aviation Airports* (Cleary and Dickey 2010), and *ACRP Synthesis 23: Bird Harassment, Repellent, and Deterrent Techniques for Use on and Near Airports* (Belant and Martin 2011). These ACRP publications were distributed to all federally obligated National Plan of Integrated Airport System (NPIAS) airports and are available at the Transportation Research Board (TRB) website.

2.1 Wildlife Hazard Assessments and Wildlife Hazard Management Plans

If one or more of the conditions identified in FAR Part 139.337b occurs, an airport operator must perform a WHA. The performance of a WHA provides airport staff or wildlife managers with a site-specific understanding of potential wildlife risks at an airport. The WHA must be conducted by a qualified airport wildlife biologist (QAWB) who meets the requirements of FAA Advisory Circular (AC) 150/5200-36A, "Qualifications for Wildlife Biologists Conducting Wildlife Hazard Assessments and Training Curriculums for Airport Personnel Involved in Controlling Wildlife Hazards at Airports."

A WHA includes 12 consecutive months of ongoing wildlife monitoring to identify the presence of wildlife species, including migratory birds, and seasonal fluctuations in the abundance, location, and behaviors of wildlife species that occur on the airport property, as well as locations meeting the 5,000-foot, 10,000-foot, and 5-mile separation criteria outside the airport per FAA AC 150/5200-33B. Based on the results of the 12-month wildlife monitoring effort, specific measures or recommendations are formulated to reduce wildlife risk at

the airport using varied techniques that are usually implemented following a hierarchical approach (see Figure 1).

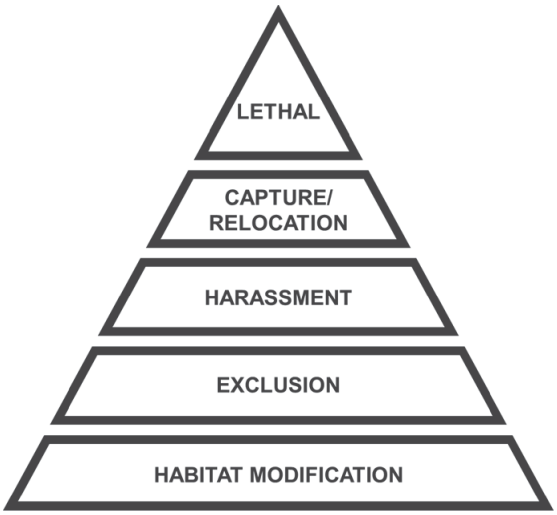
To fulfill regulatory requirements, a WHA must be conducted in accordance with the protocols set forth in 14 CFR § 139.337 and FAA's *Wildlife Hazard Management Manual* (Cleary and Dolbeer 1999). According to these protocols, a WHA must address the following:

(1) An analysis of the events or circumstances that prompted the assessment.
(2) Identification of the wildlife species observed and their numbers, locations, local movements, and daily and seasonal occurrences.
(3) Identification and location of features on and near the airport that attract wildlife.
(4) A description of wildlife hazards to air carrier operations.
(5) Recommended actions for reducing identified wildlife hazards to air carrier aircraft (14 CFR 139.337[c]).

As identified by FAA regulations, a WHA must address or include:

- Wildlife strike records and analysis: Each WHA must include a thorough review of available wildlife strike records associated with the airport.
- Wildlife populations on and near the airport: Field studies associated with the WHA must be performed to determine wildlife population including such factors as: abundance, seasonal fluctuations, movement patterns, behaviors, and periods of activity, with a particular emphasis on the species most threatening to aircraft safety.
- Wildlife attractants and land use practices: The WHA must identify potential habitat or wildlife attractants on the airport and in the vicinity of the airport.
- Wildlife management recommendations: The WHA must provide specific recommendations for reducing wildlife hazards to air carrier operations. The prioritized recommendations will serve as a framework for the development of a WHMP, should the FAA Administrator determine that one is necessary.

FAA's decision to require the preparation of a WHMP may be based on the presence and abundance of wildlife identified in the WHA, aeronautical activity, and other pertinent factors. When required, a WHMP must be developed in accordance with 14 CFR Part 139.337, subparts (c), (d), and (e) and address the responsibilities, policies, and procedures necessary to reduce wildlife hazards.



Source: BASH Inc.

Figure 1. Hierarchical approach to wildlife mitigation.

2.2 Wildlife Hazard Site Visits

A Wildlife Hazard Site Visit (WHSV) is a potential alternative to a 12-month WHA and may be more applicable to smaller GA airports. Currently, no formal guidance is available within existing FAA regulations regarding conduct of a WHSV. However, Draft FAA Advisory Circular 150/5200-38 (a draft document at the time *ACRP Report 145* was prepared) addresses the specifics for a WHSV and is the operating standard by which QAWBs conduct these studies as endorsed by FAA Airports Division. According to the Draft Advisory Circular, a WHSV has three parts: (1) background airport information, (2) wildlife field observations, and (3) a final report with recommendations. Airports use a WHSV to quickly evaluate and mitigate potential hazards on airports. An airport can also use a WHSV as a preliminary tool to determine whether a more extensive, 12-month, WHA is necessary. If an airport already has an existing WHMP, an airport can use a WHSV to evaluate potential causes for wildlife strikes to aircraft, hazards associated with land use changes or new construction activity, or whether the WHMP may need to be updated.

During the WHSV, information on the airport's wildlife hazard history, documented and suspected wildlife hazards, habitat attractants, control activities, airport operations procedures, communications of hazards through air traffic control (ATC) and pilots, and aircraft operations and scheduling are collected and compiled. A typical WHSV is conducted over a period of 1 to 3 days. A QAWB evaluates the habitat both on and surrounding the airport, records direct or indirect wildlife observations, and reviews the current WHMP (if existing), current wildlife management and control activities, and airport wildlife strike data.

A QAWB must conduct the WHSV and should make wildlife and habitat observations from a variety of locations to ensure complete visual coverage of the airport. Observations include the airport's operating surfaces and movement areas. These observations should be brief and are not as rigorous as those for a 12-month WHA. At a minimum, the wildlife observations should include:

- Documentation of avian, mammalian, and reptilian presence and relative abundance, activity, location, type of habitat used, and time and date of observations. In addition, evidence of bird activity such as fecal material and regurgitated pellets (boluses) under structures used for perching, and mammalian and reptilian scats, tracks, runs, and burrows should be annotated.
- An assessment of habitats and man-made attractants on and around airport property that may be potential wildlife attractants. The assessment should also include a review of airport and surrounding area maps and aerial photographs that allow for potential identification of waste management facilities (landfills), water treatment facilities, wildlife refuges, flowing and standing water bodies, agriculture, golf courses, stock yards, picnic areas, restaurants, and other features or habitats that may attract wildlife and have been identified by FAA as incompatible with airport operations within a 5-mile radius of the airport.
- Documentation of how the observed wildlife is using habitat, especially on the airport property and including behavior.
- An assessment of the potential for wildlife interactions with aircraft operations in the air operations area (AOA), traffic patterns, approach and departure airspace, and surrounding areas, to include an evaluation of aircraft movements for potential strike risk. A review of airport hazard advisories also should be conducted to ensure the information is specific to the hazards at the airport.

Once completed, a report is provided to the airport and FAA that summarizes the wildlife observations and any pertinent wildlife management and control recommendations. FAA reviews the WHSV report and determines if a more comprehensive 12-month WHA is required. Copies

of the report should be filed and made part of the historical record for the airport. According to the FAA's Draft Advisory Circular 150/5200-XX, the WHSV report should contain:

- A list of the wildlife species observed during the visit, along with a statement that the list is not a complete record of species using the airport.
- The federal and state status of the species observed (e.g., threatened or endangered, as applicable).
- Habitat features that may encourage wildlife to use the airport.
- Natural and man-made wildlife attractants on or near the airport.
- Strike data analysis.
- Recommendations (as substantiated by available data) to:
  - Reduce wildlife hazards identified (e.g., through habitat management, exclusion/repulsion techniques, active harassment, population control, and operational considerations).
  - Conduct an assessment (e.g., a 12-month WHA), if warranted.
  - Modify an existing WHMP, if warranted.
  - Improve communications and hazard advisories between air traffic control (ATC), pilots, airlines, airport operations, and other airport users.
  - Provide for potential alteration of aircraft operations including locations and scheduling of flights to avoid identified hazardous wildlife concentrations.
  - Take no action (if applicable).

CHAPTER 3

Safety Management System Overview

The integration of an airport's wildlife hazard management (WHM) program and Safety Management System (SMS) offers a best-practice approach to a comprehensive safety system in which all hazards can be managed consistently and comprehensively. Whether or not the airport has implemented an SMS, specific aspects of SMS can be applied to any WHM program regardless of complexity, size, or structure. This chapter provides a brief overview of SMS; a more thorough description of SMS and application of SMS to a typical airport WHM program is presented in Chapter 4.

As described in the Draft FAA Advisory Circular 150/5200-37A, Safety Management Systems for Airports, SMS is "an integrated collection of processes and procedures that ensures a formalized and proactive approach to system safety through risk management" (FAA 2012a). The International Civil Aviation Organization (ICAO) defines SMS as a systematic approach to managing safety, including the necessary organizational structures, accountabilities, policies, and procedures.

The SMS defines how an airport intends to manage safety as an integral part of its business management activities. The functional result of an SMS is to proactively manage risk, detect and correct safety problems before those problems result in an accident or incident, and reduce the impact/cost of incidents. FAA states that an SMS "enhances safety, ensures compliance with applicable regulatory standards, and can be integrated into all aspects of airport operations, including business and management practices" (FAA 2012a).

An SMS typically will:

- Identify root causes and contributing factors to ensure controls, training, and oversight.
- Reduce risks through hazard identification, mitigation management, and risk ranking and prioritization.
- Present trends for improved safety awareness and actions.
- Hold staff/tenants accountable for safety performance.
- Facilitate safety ownership through participation.
- Adjust training to match safety gaps assessed through trends.

SMS provides an opportunity to apply similar policies and processes to wildlife hazards as to other safety concerns such as accidents and incidents, airside construction projects, and operational changes. An intrinsic component of airport safety is the successful oversight and management of wildlife, including formal and documented assessment of specific wildlife hazards associated with species, behaviors, quantities, habitat, and mitigation measures. "SMS supports a proactive approach to safety through a framework of tools and methodologies to address safety issues. It also establishes a safety-conscious environment and culture. It encompasses all personnel in any operational area since observation, evaluation, and reporting are integral to achieving effective safety-related outcomes" (FAA 2012a).

Source: Landry Consultants LLC

Figure 2. SMS components.

SMS comprises four key components, as shown and described in Figure 2. Safety Policy establishes the foundation of SMS, documenting how the airport will deploy the SMS; Safety Risk Management (SRM) and Safety Assurance are operational components of the system; and Safety Promotion ensures "that individuals with a role in SMS are properly trained and that safety issues identified through any of the activities associated with the components are communicated" (FAA 2012a).

Safety Policy. Safety Policy provides the foundation or framework for the SMS. It outlines the methods and tools for achieving desired safety outcomes. Safety Policy also details management's responsibility and accountability for safety.

Safety Risk Management (SRM). As a core activity of SMS, SRM uses a set of standard processes to proactively identify hazards, analyze and assess potential risks, and design appropriate risk mitigation strategies.

Safety Assurance. Safety Assurance is a set of processes that monitor the organization's performance in meeting its current safety standards and objectives and contributes to continuous safety improvement. Safety Assurance processes include information acquisition, analysis, system assessment, and development of preventive or corrective actions for nonconformance.

Safety Promotion. Safety Promotion involves processes and procedures used to create an environment where safety objectives can be achieved. Safety Promotion is essential to creating a positive safety culture in an organization. Safety culture is characterized by knowledge and understanding of an organization's SMS, effective communications, competency in job responsibilities, ongoing training, and information sharing.

CHAPTER 4

The Safety Management System and Wildlife Hazard Management

Fundamentally, a Safety Management System (SMS) comprises a series of policies, processes, procedures, and documentation that allows management and staff to more effectively understand safety trends within the airport environment. Quality data (information), data management, and data trending allow for a proactive ability to forecast possible safety events. Within an airport's Wildlife Hazard Management Plan (WHMP) or diverse WHM programs, such data play a significant role in the development of activities, including appropriate controls and mitigations such as habitat modification, exclusion, population control, hazing, depredation, and operational considerations. Results derived from data management tools should be used to support all airport WHM program decisions and associated actions and to assist in prioritizing the most urgent (highest risk) wildlife hazards. Regardless of the size, formality, or function of the airport's WHM efforts, the four SMS components can assist with standardizing safety processes and procedures by establishing a framework and safety risk thresholds that guide prioritizing and funding actions to prevent or mitigate potential risks associated with wildlife hazards.

This chapter provides an overview of the four SMS components and discusses their specific application to any size or operation of an airport WHM program. If the airport has implemented an SMS, the activities associated with these components would align with the current SMS; however, if the airport does not have an SMS, the proposed activities could be developed in conjunction with or as an enhancement to an existing WHM program. The Safety Risk Management (SRM) and Safety Assurance components are the most relevant, applicable, and useful to implement as part of a formal SMS approach to WHM; if possible, however, all four SMS components are recommended to be implemented as a means to establish a comprehensive and effective SMS.

4.1 Safety Policy

Safety Policy guides how the airport structures and conducts its SMS. This component identifies the roles, responsibilities, and duties for the safety manager, accountable executive, and other applicable staff, such as wildlife managers, operations staff, and wildlife biologists. It also defines duties for safety and wildlife committees and their participants, and it works in conjunction with the identified roles and responsibilities of other assigned SMS staff to ensure accountability at all levels of the organization. Furthermore, Safety Policy outlines the metrics by which the program's success is to be measured. The Safety Policy typically includes specific objectives and goals that reflect the program and expected outcomes and that are, most importantly, measurable and measured. These actions, targets, and milestones are reviewed and updated annually (or more frequently) to match Safety Policy goals with the specific strategic and tactical actions necessary to meet the objectives. Safety Policy objectives align with the SMS Safety Assurance component as part of the overall program evaluation and assessment process, along with continuous improvements and analysis of hazard mitigations.

Safety Policy Statement

The Safety Policy Statement provides direction for the SMS. This document guides and commits the organization, management, staff, and tenants to safe airport operations. The statement outlines management's commitment to safety and invites tenants to participate in the SMS. It often comprises a mission, a vision, and a statement of core values, and it is backed by quantifiable SMS objectives or goals. An airport's Safety Policy Statement should take into consideration safety concepts that can apply equally to all aspects of airport safety, including airside operations, staff and tenant safety, and wildlife management. The statement should be easily understandable by managers, employees, and tenants, and it should take into account the airport's complexity and structure (FAA 2012a).

Safety Policy Statement Applied to Wildlife Hazard Management

As applied to WHM, an airport's SMS Safety Policy Statement should:

- Maintain a relatively broad focus that does not restrict the WHM program.
- State the WHM program goals.
- Take into account the wildlife and associated safety aspects of the WHM program and include realistic objectives that a WHM program can achieve. For example: a WHM-related objective could be to reduce the need for wildlife depredation through increased pyrotechnics harassment practices, or to implement new habitat management strategies that reduce the presence of wildlife attractants.

Figure 3 presents a sample Safety Policy Statement as a reference. All aspects of the Safety Policy Statement can be applied to airport WHM programs including:

- Establishing a safe environment for staff and tenants through reduction of bird strikes and focused habitat management.

EXCELSIOR AIRPORT

1 Airport Boulevard
Monterey, CA 90293

June 7, 2012

The Excelsior Airport is committed to the implementation of a Safety Management System (SMS) that enables its management, employees, the airlines, tenants, and other business partners to operate in a safe environment. Safety is among the Airport's highest priorities. The Airport is dedicated to creating an environment that minimizes exposure to hazards and risks, expects continuous safety improvement, and encourages confidential reporting of any safety related situation, incident, or accident. We will ensure that necessary policy direction and resources are available to enable the success of the SMS, compliance with standards and regulations, and enhanced operational safety.

John R. Smith

John R. Smith
Airport Manager

Source: FAA Draft AC 150/5200-37A, Safety Management Systems for Airports

Figure 3. Sample Safety Policy Statement.

- Minimizing exposures to hazards and risks through review of wildlife management mitigations and successes, and through tracking, recording, and managing high risk species and behaviors.
- Encouraging and managing reporting of wildlife strikes by staff and tenants, and encouraging continuous improvements through formal development and monitoring of WHAs, WHSVs, and WHMPs.

Roles and Responsibilities

- The airport's SMS-related staff duties should include participation from wildlife management staff, qualified airport wildlife biologists (QAWBs), and operations team members that are involved in the airport's WHM activities such as harassment, deterrence, depredation, and communications.
- Management may want to assign specific staff to participate on SMS committees or establish and document core duties for those staff assisting in managing wildlife at the airport, including oversight of wildlife during construction operations to ensure that construction activities do not increase or encourage wildlife presence.

Objectives and Metrics

- The SMS establishes key metrics or key performance indicators (KPIs) as a means to measure safety at the airport.
- WHM metrics should be included in formal reporting and tracking to indicate changes in wildlife risk conditions at the airport. Establishing metrics requires setting a baseline of existing data (current wildlife management efforts) and implementing operational controls to subsequently trend upward or downward activities that are also referred to as leading or lagging indicators. Much of this information is collected or established during Part 139 inspections, the execution of WHAs, or as part of the overall WHMP. However, the data may not be centralized or documented in a way that provides trending opportunities. Data can be collected in spreadsheets or using custom software applications. The operational complexity and size of the airport typically drives the need for a larger, more robust system, but a spreadsheet can become a valuable tool with little to no cost beyond a few courses or instructional guides, plus the time to input an initial, solid set of data. Regardless of the system used, the goal is to compile sufficient information to observe trends. For example, a single event or incident reported every 5 to 10 years may not provide sufficient information to detect trends. In some cases, trends can be detected within a few months and in other cases multiple years' data, such as migratory patterns and seasonal habitat changes, would be required to produce sufficient outputs.
- Baseline data could include:
  - Wildlife counts during daily operations.
  - Wildlife counts during seasonal and migratory periods.
  - Number of wildlife strikes by group or guild (birds, mammals, reptiles) reported by airport staff and tenants. (Trends in reporting activities by staff and tenants could be used to encourage and promote reporting activities.)
  - Comparison of local wildlife strike data to the national FAA Wildlife Strike Database to determine reporting behaviors.
  - Type, location, and frequency of harassment, by wildlife group or guild.
  - Number and type of captures and depredations, including locations of activity.
  - Type of habitat (e.g., composting, wastewater, natural wetland, golf course) and mitigation by location and distance from the airport's airside operations.
  - Proximity of wildlife to the airport's airside operations, including locations within perimeter fence and outside perimeter fence at documented distances such as 5,000 feet, 10,000 feet, 5 miles, and greater than 5 miles.

- Once baseline data have been collected, metrics can be established to access, analyze, and trend activities. Most airport staff and wildlife managers are aware of the most significant wildlife concerns at and surrounding their airport; consequently, initial metrics should focus on known problems. Additional goals and metrics can be established later as more data are collected and analyzed. The metrics to support program goals and objectives should be realistic and should evolve as the program information is collected and applied.
- Examples of wildlife goals include:
  - Maintain or reduce wildlife activities during construction.
  - Decrease wildlife through habitat changes and modifications.
  - Increase reporting of wildlife strikes and hazards from staff and tenants through promotional campaigns.
  - Decrease wildlife during seasonal migrations through increased or more sophisticated harassment techniques.
  - Increase captures and decrease depredations.
  - Decrease large mammal and predator presence through rodent control or fencing projects.
  - Decrease wildlife presence immediately outside of the perimeter fence through awareness campaigns, rubbish removal and maintenance, habitat removal, etc.
- In addition to the airport operations or WHM staff data collection and analysis process, the Wildlife Hazard Management Risk Assessment Tool (WHaMRAT) can assist in setting a baseline Wildlife Risk Score from which trends can be assessed as necessary in conjunction with the overall WHM program. For example, changes in the Wildlife Risk Score can be examined for quarterly or annual reviews of the WHM program, on the basis of seasonal changes, or on an ad hoc basis to determine if—and how—changes in existing operational controls or new mitigations have affected the risk score.

4.2 Safety Risk Management

Contrary to popular opinion, safety does not mean that airports operate or exist in an environment that is free from risk. With that in mind, the aim with SRM is to create a safe operation that is free from unacceptable risk. This means that airport operators and safety personnel recognize that risk is unavoidable and that hazardous conditions exist within all aviation operations. The goals of SRM are to identify and mitigate hazards, and to prevent harmful consequences or outcomes from occurring.

SRM is a formal, structured set of processes used to proactively identify hazards, classify and prioritize associated safety risks, apply corrective actions to mitigate risks, and continuously improve operational safety. As a component of the SMS, the objective of SRM is to provide supporting information for decision makers by identifying hazards, analyzing safety risk, assessing safety risk, and developing controls (FAA 2012a).

Data trending outcomes (leading indicators) or a specific wildlife-related accident or incident may cause airport or wildlife management staff to formally assess a particular operation, procedure, or protocol to better understand the underlying wildlife hazards and associated risks. Conversely, staff and management may decide to conduct an overall WHM program risk assessment to determine the general well-being of the airport's wildlife program as part of a baseline review.

The SRM process allows for a standardized procedure and approach to document and quantify hazards and risks, and to develop specific mitigations and monitoring programs to observe whether existing wildlife management controls (efforts) are improved or diminished through new mitigations.

To effectively prioritize and mitigate risks, it is important to develop a consistent, standardized risk analysis method. The definitions and categories used to classify risk should be applied consistently to all safety risks within the airport's system; for example, classifications should be used consistently for operations and wildlife Safety Assessments (SAs). Doing this will ensure not only the even application of risk analysis, but also the accuracy of tracking and trending.

Risk analysis and assessment may be conducted by a variety of subject matter experts. These experts weigh in on the potential risk scenarios by using either a standardized or organizationally developed risk matrix such as the example provided in Figure 4. Then, either individually or as a group, the experts analyze the hazards and rank and record the risks for resolution, monitoring, and reporting.

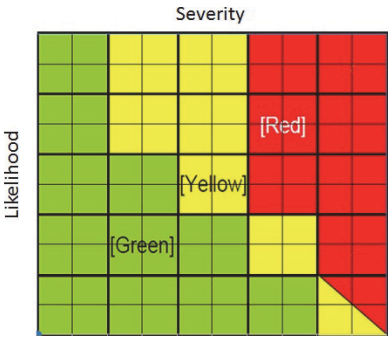
Development of a risk matrix can be unique to each airport's needs. However a risk matrix must include a variety of risk-severity definitions and thresholds on the *x*-axis and a series of likelihood (probability) thresholds on the *y*-axis. The goal is to create a matrix with sufficient levels of the details needed to rank or score specific hazards using quantitative and qualitative means. Developing a realistic risk matrix and subsequent model for assessing wildlife hazards includes the challenge of determining:

- Wildlife severity and likelihood of strike.
- Airport operations and tempo by aircraft type.
- Habitat presence, both on-airport and off-airport, and evaluation of attraction to wildlife.
- Habitat mitigation effectiveness.
- Wildlife mitigation effectiveness.

Qualitative analysis uses non-measurable data, such as past experience, anecdotal evidence, or observation, to make decisions or determinations. Quantitative analysis uses verifiable measurable data to make decisions or determinations. Most risk assessments use a combination of qualitative and quantitative analysis, such as industry expertise and knowledge along with strike data.

In analyzing both severity and likelihood, the most accurate risk ranking outcomes result from the application of quantitative data as part of the analysis. Analyses with insufficient or incomplete quantitative data sets must rely on the inclusion of as many subject matter experts as possible, or on estimates of data based on other sources. Individual years of experience, lessons learned, and memories of past events can be extremely useful in determining the severity and likelihood of a hazard.

An organization's risk tolerance determines the level of risk it is willing to knowingly accept—and, by extension, its requirements for mitigating risks. An airport's risk tolerance will dictate the prioritization of risks for mitigation treatment, including which risks are deemed acceptable



Source: Adapted from FAA Order 8040.4A, Safety Risk Management.

Figure 4. Risk matrix.

and will not be mitigated. The organizational risk tolerance is represented directly on the risk matrix. In Figure 4, the red areas represent high risk, whereas the yellow and green areas represent moderate and low risk, respectively. In this example, the organization could determine several factors related to risk tolerance and prioritization:

- High risk is unacceptable and requires mitigation.
- High risk can be defined by any risk that can be plotted within the red zone.
- Moderate risk is the highest acceptable risk, but should be mitigated whenever possible.
- Low risk may be acceptable without restriction or limitation; however, it should be tracked and monitored to ensure it does not become a moderate risk. (Likelihood would be a factor to monitor in this case.)
- Treatment or mitigation activities should be prioritized based on risk, with high risk hazards always given the highest priority.

Determining the organization's risk tolerance is a critical decision that should be undertaken and accepted by the entire airport, including representatives from operations, risk, maintenance, and wildlife management at a minimum. Regulatory requirements may dictate or override an individual airport's risk tolerance level.

The WHaMRAT provides risk matrices that can be used to assist an airport in producing an Overall Aggregate Wildlife Risk Score representative of current wildlife hazards at the airport. These matrices are presented as templates adapted from the matrices presented in the safety literature, including FAA publications. The matrices in the WHaMRAT use definitions for severity and likelihood and take into consideration number and type of aircraft operations, habitat parameters, and mitigation efforts as adjustments. Changes made to match or update an airport's WHM program are reflected in the WHaMRAT, and could result in a change in the Overall Aggregate Wildlife Risk Score. The SRM component of SMS would encompass the WHaMRAT results using the standard five-step risk assessment process described in this chapter. Specific guidance and definitions to use with the WHaMRAT are provided in Appendix C.

Proactive hazard identification and mitigation as practiced under SRM are core to an airport's SMS and reflect the most significant change to Part 139 operations. A successful hazard identification process provides standardization, consistency, and comprehensiveness in its collection of information about potential hazards. It also allows for the possibility that not all potential hazards reported will present an actual safety risk, and that some potential hazards may therefore need to be removed from the SRM process. Additionally, the hazard identification process should ensure that hazards are appropriately recorded, stored, and documented at the beginning of the SRM process to assist in further analysis and downstream tracking and trending.

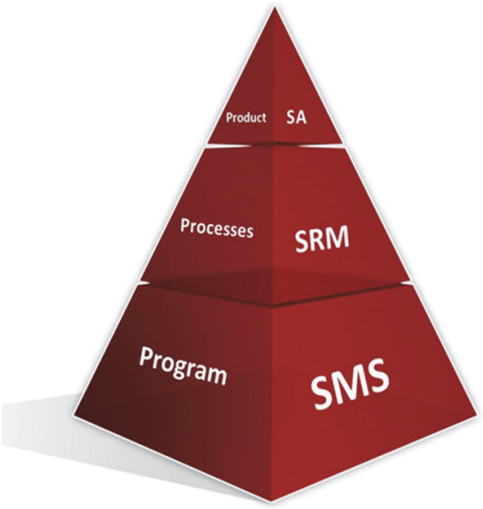
The process used to analyze risk is commonly called a Safety Risk Assessment (SRA) or simply a Safety Assessment (SA). SRAs/SAs can be conducted by a formal panel that includes various stakeholders or as part of an airport's daily operations through real-time operational assessments and decisions. Both processes fall under the SMS umbrella and share key SRM processes. Figure 5 illustrates the SMS, SRM, and SA relationships.

The SA results in a product or outcome within the SRM component. SAs employ a formal five-step process as presented in Figure 6. An additional function that is not articulated in the five steps but is critical to the SRM process is the monitoring of mitigations to assess whether new hazards or diminished controls result from the mitigation, to determine if the mitigation is successful, and to decide whether new permanent safety controls or efforts should be implemented as part of the mitigation. These monitoring activities lead to continuous improvements that are addressed as part of Safety Assurance. Each of the five steps is briefly described in Figure 6, and an example of the process is provided in the outlined text.

Safety Assessment (SA) is the risk assessment (e.g., conducted by a panel of subject matter experts).

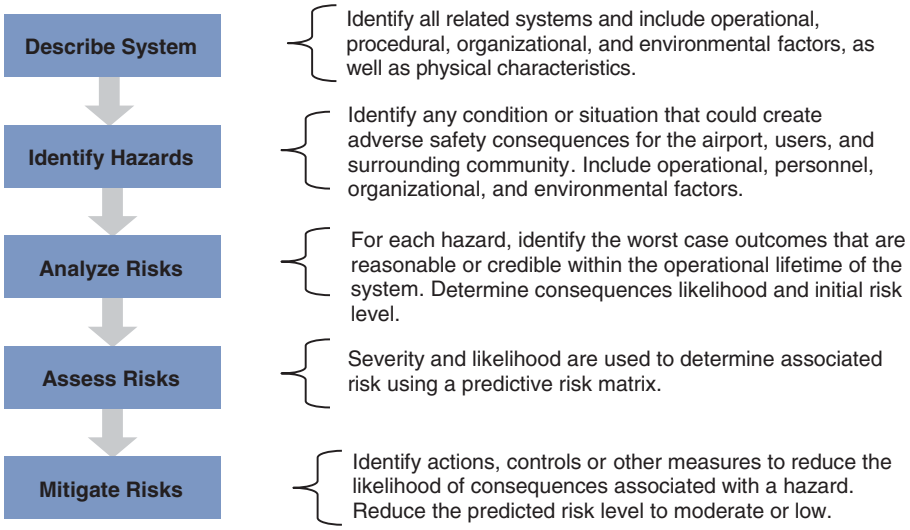
Safety Risk Management (SRM) is the process/program of identifying hazards, analyzing and assessing the risks, and mitigating the risks.

Safety Management System (SMS) is the overall system of processes, procedures, policies, etc.



Source: Landry Consultants LLC

Figure 5. SMS, SRM, and SA relationships.



Source: FAA SRM panel facilitation slide template

Figure 6. The formal five-step SA process.

Example of a Formal Safety Assessment of a Wildlife Safety Concern

1. **Define the System:** Because of recent heavy rainfall, a retaining pond adjacent to an airport runway has filled with rainwater and is creating a wildlife attractant to Canada Geese. The system state is heavy rainfall, and the subsequent filling of the retaining pond. At least 12 geese were observed multiple times in the last day. The cause is wildlife attractant (rainwater).
2. **Identify Hazard(s):** The hazard is the increased presence of Canada Geese within the proximity of an active runway. The effect or consequence is a potential wildlife strike with potential engine ingestion.

3. **Analyze the Risk(s):** Based on the current scenario and using the risk matrix in Figure 4, the severity (severity is always assessed first) is considered a 4 given that Canada Geese have severe impacts on aircraft because of their body mass; the likelihood is a 2 because of the abundance or number of Canada Geese observed (12).
4. **Assess the Risk(s):** Using the risk matrix in Figure 4, the plotted risk falls into the yellow quadrant, reflecting a "moderate" risk. Per established airport risk definitions and thresholds, a moderate risk requires that mitigation measures or additional controls be implemented to reduce the risk of the hazard.
5. **Mitigate the Risk(s):** The airport's operations and wildlife management teams assess existing safety controls that include recurring pyrotechnics harassment practices and determine that the most effective mitigation is to install wildlife bird balls to restrict Canada Geese from landing on the water and retaining pond perimeter. An additional mitigation considered is draining the pond.

The team also establishes a wildlife monitoring program to count the number of Canada Geese in the area. The monitoring program includes three inspections daily within week 1, one inspection daily during week 2, and weekly inspections for an additional month. Based on monitoring results, additional mitigations may be required to reduce the risk.

After a month, no Canada Geese are observed in the retaining pond area. The hazard is reassessed by the team. The severity remains assessed as a 4 because the risk of severity is not diminished (Canada Geese are considered "moderate risk" due to their size). The likelihood, however, is lowered to a 1, because of the number of Canada Geese now observed in the area (none). The risk rank falls into the green quadrant, corresponding to a "low" risk. Based on the reassessment, no additional monitoring is conducted. The team logs the information in the WHM software program or notebook for future reference and reporting.

Notes:

- **Cause:** Events that lead to or result in a hazard or hazardous condition.
- **Hazard:** Any real or potential condition that can cause injury, illness, or death to people; damage to or loss of a system, equipment, or property; or damage to the environment.
- **Effect, Consequence:** Outcome or harm of a hazard for a given system state.

Safety Risk Management Applied to Wildlife Hazard Management

The SRM component of SMS as applied to WHM could include the following proposed activities. (See also Objectives and Metrics under Section 4.1 in this chapter as a means to begin hazard analysis through trending.)

Hazard Identification and Sources

- Conduct a WHA or WHSV or review existing assessment.
- Review the WHMP and compile into a comprehensive hazard list for tracking and trending.
- Conduct a review of Part 139 wildlife inspections for trends.
- Conduct a wildlife hazard review through Part 139 inspection records analysis, wildlife strike reports, and FAA Wildlife Strike Database data review, current information collected by third parties and staff, and assess the findings to find trends and associated possible hazards.

- Prioritize the list into a top-10 list for immediate hazard assessment and risk ranking.
- Reprioritize the list after assessment to identify and rank hazards by risk level (red, yellow, green).
- Identify various mitigations and additional efforts necessary to reduce the risk ranking.
- Assign costs to each mitigation, including complete redesigns, removals, or refurbishments; additional safety devices, such as hazing equipment; and increased staffing, additional training, and new or revised procedures or protocols.
- Identify existing controls (e.g., habitat management, harassment, relocation, and depredation) and other mitigations used to manage wildlife. Begin to assess quality and effectiveness of the existing controls through documentation and review.

Formal Use of SRM

- Conduct individual five-step SAs for the top-10 hazards (identified through the various means and processes identified in the hazard identification options listed), and document risk ranks, additional mitigations, and monitoring plans for each hazard. The SA can be accomplished all at once or over a period of time, depending on the availability of staff.
- Use the WHaMRAT to perform a comprehensive wildlife SRM assessment for the airport and document results.
- Determine how frequently wildlife hazard reassessment will be performed and assign responsibility to appropriate staff. (For additional guidance on continuous improvement and monitoring, see Section 4.3, Safety Assurance.).

Document Mitigation Measures, Monitor Programs, and Assess Outcomes

- For each of the top-10 hazards, document changes to the hazard risk ranking based on additional mitigation results, and identify whether the additional mitigations were successful through observations and data collection and analysis.
- Assess wildlife monitoring plans to determine if the duration and frequency of existing monitoring remains appropriate.
- Integrate SRM into the WHMP for annual review. Reports from the data trending, metrics results, and hazard risk ranking efforts, as well as the Overall Aggregate Wildlife Risk Score from the WHaMRAT could be included in the WHMP as an appendix, a separate document, or as a presentation for the WHMP annual review. The additional documentation could provide resources for risk-based decision making and discussion, and aid in prioritization of mitigation activities, funding, and assignments for the following year.
- Consider changes in programs, outcomes, and mitigations for continuous improvements based on the information collected and analyzed.

4.3 Safety Assurance

It is important to note that

> SRM and Safety Assurance work together. The SRM process provides a system analysis, the identification of hazards, and the analysis and assessment of safety risk. As a result, safety risk controls are developed and, once they are determined to be practicable in reducing safety risk to an acceptable level, these controls are employed operationally. Safety Assurance is used to ensure that safety risk control strategies are in place, assess whether they are achieving their intended safety risk reduction objectives, and monitor for unintended consequences. If the controls are not adequately reducing safety risk, they are modified and/or additional safety risk controls are developed through SRM (FAA 2012a).

Safety Assurance is a set of processes used to monitor the organization's performance in meeting its current safety standards and objectives, and to contribute to continuous safety improvement. Safety Assurance essentially serves as a "check and balance" to ensure that the SMS processes, procedures, and risk mitigation strategies are having their intended effect. Safety Assurance ensures that

the program goals are managed, measured, and continuously improved as the program evolves. It allows management to verify and validate that the SMS is operating as designed and is actually improving safety. Also included in Safety Assurance is the method by which data will be collected, re-identified if necessary, and reported within the organization. Similarly, wildlife hazards and associated controls and mitigations are assessed annually through WHMP reviews and updates.

The primary task of Safety Assurance is control, achieved through safety performance monitoring and measurement (the process by which the safety performance of the organization is verified in comparison with the Safety Policy and approved safety objectives). Safety Assurance control is exercised by monitoring and measuring the outcomes of activities that operational personnel must engage in for the delivery of services by the organization. Thus, a process of permanent examination, analysis, and assessment of these controls must continue throughout the daily operation of the system. The Safety Assurance process mirrors that of quality assurance, with requirements for analysis, documentation, auditing, and management reviews of the effectiveness of the safety risk controls. The organization's WHMP provides long-term, species-specific or attractant-specific measures, with prioritized target completion dates based on a WHA, WHSV, or ongoing wildlife data collection and analysis. The foundation for the Safety Assurance component of the SMS exists in the airport's current WHM program.

A core SMS concept is continuous improvement. Safety Assurance provides the tools for the SMS to accomplish continuous improvement by (1) ensuring adherence to all measures implemented, (2) reviewing and evaluating all actions taken to assess how well they produce the desired effects, and (3) monitoring the impact of business activities on safety to help determine where the organization's efforts should best be directed. Safety Assurance differs from SRM because the focus of Safety Assurance is to improve the performance of the SMS itself, rather than the individual hazards and their associated risks.

Safety Assurance Applied to Wildlife Hazard Management

The data and information collected through the SRM are critical to ensure that the SMS and WHM program meet identified targets and goals. To leverage the additional effort undertaken in the SRM process to fully realize its benefits and to evaluate the successes and improvement opportunities of the SMS, it is necessary to identify and measure each WHM control or mitigation initiative against specific goals. The SMS goals should be derived from the objectives published in the organization's Safety Policy Statement, thereby closing the audit loop. The WHaMRAT can be used to assist with development of baseline risk values that can be incorporated in the periodic and annual wildlife review. Documenting the ongoing successes or challenges associated with wildlife controls or mitigations should provide a more accurate guide to what works the most effectively at the airport.

Assessing Metrics

- Link wildlife hazard risk scores to metrics and performance indicators identified in the Safety Policy.
- Measure performance of wildlife mitigations and wildlife management controls against documented wildlife hazards. Count and trend bird strike and other wildlife data and determine if mitigations result in fewer strikes or strikes clustered in different areas of the airport. Ensure that enough detail is provided to improve effective mitigation measures.

The Assurance Process

- Integrate a formal process to assess changes in WHM and effectiveness using the WHaMRAT as a baseline.
- Measure changes as needed and include them in the annual WHMP review.

Continuous Improvements

- Assess whether wildlife mitigations, wildlife monitoring, or WHM practices are improving safety goals documented in the Safety Policy.
- Make corrections to the program and reassess whether these changes are improving the wildlife hazard condition.

4.4 Safety Promotion

Safety Promotion includes processes and procedures used to create an environment in which safety objectives can be achieved. Key elements of Safety Promotion are training and communication. Communication can take multiple forms, such as posters, meetings, alerts, safety fairs, and safety exhibits. Within the SMS, the objective of Safety Promotion is to improve the safety culture of the entire organization. Thus, as part of Safety Promotion, communication must reflect management's actions to maintain a safety culture that creates trust and thereby improves operations. Building a strong safety culture requires key organizational activities that promote a high level of risk awareness on the part of the employees, along with a sense of personal responsibility for reducing risk. Senior management commitment and demonstrated leadership in promoting safety are essential ingredients in the enhancement of a strong safety culture (Ayers et al. 2009).

Because each airport's culture is unique, airport management at the top levels should work to establish the appropriate safety culture. This means making a commitment to safety, enforcing a policy of non-retribution against anyone who submits incident, accident, or hazard data, retraining without penalty or stigma when safety is compromised, and promoting a positive attitude toward safety and individual responsibility at all levels of the organization.

The processes and procedures specified in the Safety Policy, SRM, and Safety Assurance components are the structural building blocks of the SMS. However, the organization must also establish processes and procedures that allow for communication among operational personnel and with the organization's management. Organizations must make every effort to communicate their objectives, as well as the current status of the organization's activities and significant events. Likewise, organizations must supply a means of upward communication in an environment of openness.

Safety Promotion Applied to Wildlife Hazard Management

Collaboration, communication, and shared knowledge, beliefs, and values are critical to the SMS and WHM programs. The foundation of a Safety Promotion program is the means to communicate safety information, ensure understanding of core SMS components, and encourage participation and collaboration from the airport stakeholder community. SMS Safety Promotion consists of three distinct elements that could be applied to WHM: training, promotional materials/outreach, and safety culture.

Training

- With the implementation of a formal SRM process for WHM, key staff would benefit from formal training in risk-based assessment and documentation as described in FAA AC 150/5200-36A, Qualifications for Wildlife Biologist Conducting Wildlife Hazard Assessments and Training Curriculums for Airport Personnel Involved in Controlling Wildlife Hazards on Airports (FAA 2012b).

- Staff and tenants also would benefit from training on the value of data quality, consistent bird strike and wildlife reporting, monitoring, and management reports.
- Training to support promotional campaigns could include briefings at staff meetings and follow-up on bird strike and other wildlife reports.

Promotional Materials/Outreach

Formal SRM and WHM program promotion can make use of a variety of methods to increase effectiveness, visibility, and participation throughout the entire airport stakeholder community. Outreach options include:

- Newsletters, posters, and bulletins regarding wildlife tracking and trending.
- Additions to meeting agenda items to discuss wildlife reporting.
- Outreach activities such as tenant site visits to describe proper process for wildlife reporting and wildlife observation data collection.

Safety Culture

- Safety culture and WHM are linked by training and communication to improve reporting and collaboration, and to develop a culture of understanding that wildlife management is important to all stakeholders.
- Safety culture is reflected in management's commitment to implementing controls and mitigations to manage wildlife more effectively.
- Tenants, especially airlines, contribute to the safety culture by training and managing their staff to adhere to and value processes such as removal of wildlife attractants to reduce wildlife threats.

4.5 Safety Management Programs

One of the most valuable aspects of a successful SMS is the establishment of an airport hazard condition report or hazard "baseline." Management's establishment of the baseline makes it possible to understand the risks associated with existing or emerging hazards. Often, the condition report or baseline is developed as part of a comprehensive hazard assessment in which all aspects of the airport's operations are investigated for potential hazards or hazardous conditions. Hazards can originate from various data sources, including databases and software systems (as described in the Objectives and Metrics section), terminal inspections, airfield hotspots, accident and incident reports, fire and medical responses, program audits, safety observations, operations logs, foreign object damage (FOD) reports, operational changes, construction projects, database queries for trend reporting, and bird strike and other wildlife reports.

Once a baseline collection of hazards, status, and risk rankings has been established, management can monitor the hazards and risks through identified KPIs. KPIs can be divided into leading and lagging indicators. Lagging indicators focus on data already captured or documented (e.g., number of bird strikes, accidents and incidents, FOD reports, medical runs, etc.). Leading indicators look to the future and focus on change and how it impacts the operation or organization. Leading indicators provide alerts before a trend occurs or is observed. For example, a leading indicator could be the type and frequency of a specific mitigation that would be documented and managed through program monitoring and oversight. Various mitigation strategies could be deployed simultaneously or sequentially to determine which mitigation provides the most effective outcomes. The results could contribute to program changes and course corrections, and help to prioritize budget items. The value of accurate hazard and mitigation data aids the organization and management in making better risk-based decisions.

Example of a Wildlife Leading Indicator and Associated Actions

An airport wildlife manager is investigating the use of a variety of new wildlife harassment techniques and equipment, specifically to manage gulls congregating at the end of an active taxiway due to a large multi-phase construction project occurring outside of the perimeter fence. The wildlife manager has observed a steady increase in wildlife activity reports from daily Part 139 inspections. In addition, pilot strike reports associated within the same taxiway area have increased over the last 2 months.

1. The wildlife manager compiles the Part 139 strike reports, assesses whether an increase in air operations has occurred in the area (to determine whether operations may be the source of the increased strike rate), and observes a leading indicator that a rise in gull presence and strikes appears to be occurring.
2. To address the possible increase in strike incidents associated with the gulls, the manager selects three techniques and options to test for effectiveness to determine whether one or more of the techniques will reduce the uptick in strikes in the taxiway area.
3. The manager assigns staff to implement each of the techniques for a 2-week period and monitors reports for gull sightings and strikes.
4. After 6 weeks, the manager compiles the information from each of the techniques and observes which technique appears to be the most effective in gull control.
5. The manager implements a standard operating procedure (SOP) to include the new technique until the construction project is completed.
6. After the construction project ends, the manager confirms that the gull presence does not continue in order to confirm that the root cause of the uptick in gull presence was the construction activity.

The manager documents the program results and provides a recommendation for future construction that the technique be used as a SOP.

According to the Standardization Workgroup of the Safety Management International Collaboration Group (SM ICG), "Safety management is becoming the standard for aviation safety worldwide. It is a tool that assists managers to make decisions based on the risks that exist in their organizations or in their environments. Risk management is one of the main components of safety management as it encompasses the assessment and mitigation of safety risks, to which organizations are exposed" (SM ICG 2013). One of FAA's strategic priority initiatives includes risk-based decision making that strives to "Build on safety management principles to proactively address emerging safety risk by using consistent, data-informed approaches to make smarter, system-level, risk-based decisions" (FAA 2013c).

The WHaMRAT provides airport and wildlife management staff with an instrument to assist in developing a baseline for a wildlife hazard and risk assessment. The WHaMRAT supplements manual investigative processes such as compiling and reviewing strike data, habitat management information, depredation and harassment records, and operations reports. The WHaMRAT is intended to serve as a supplemental tool to conduct a hazard assessment and identify the Overall Aggregate Wildlife Risk Score for the airport. The staff participating in a hazard assessment should consider all aspects of the data and information collected, not merely output from the

WHaMRAT; however, the WHaMRAT can be used to explore various mitigation scenarios to analyze whether current and future proposed mitigations may assist in reducing the Wildlife Risk Score. In many cases, airport management relies solely on manual reports to assess hazards and determine risk scores. The WHaMRAT was developed to facilitate the hazard assessment process and to provide an electronic tool to capture information that can be used on a recurring basis for decision making and trend analysis.

Figure 7 demonstrates a typical SRM process depicting an eight-step WHA that includes use of the WHaMRAT. A detailed User Guide describing how to use the WHaMRAT and including information on underlying calculations and assumptions is provided in Appendix C.

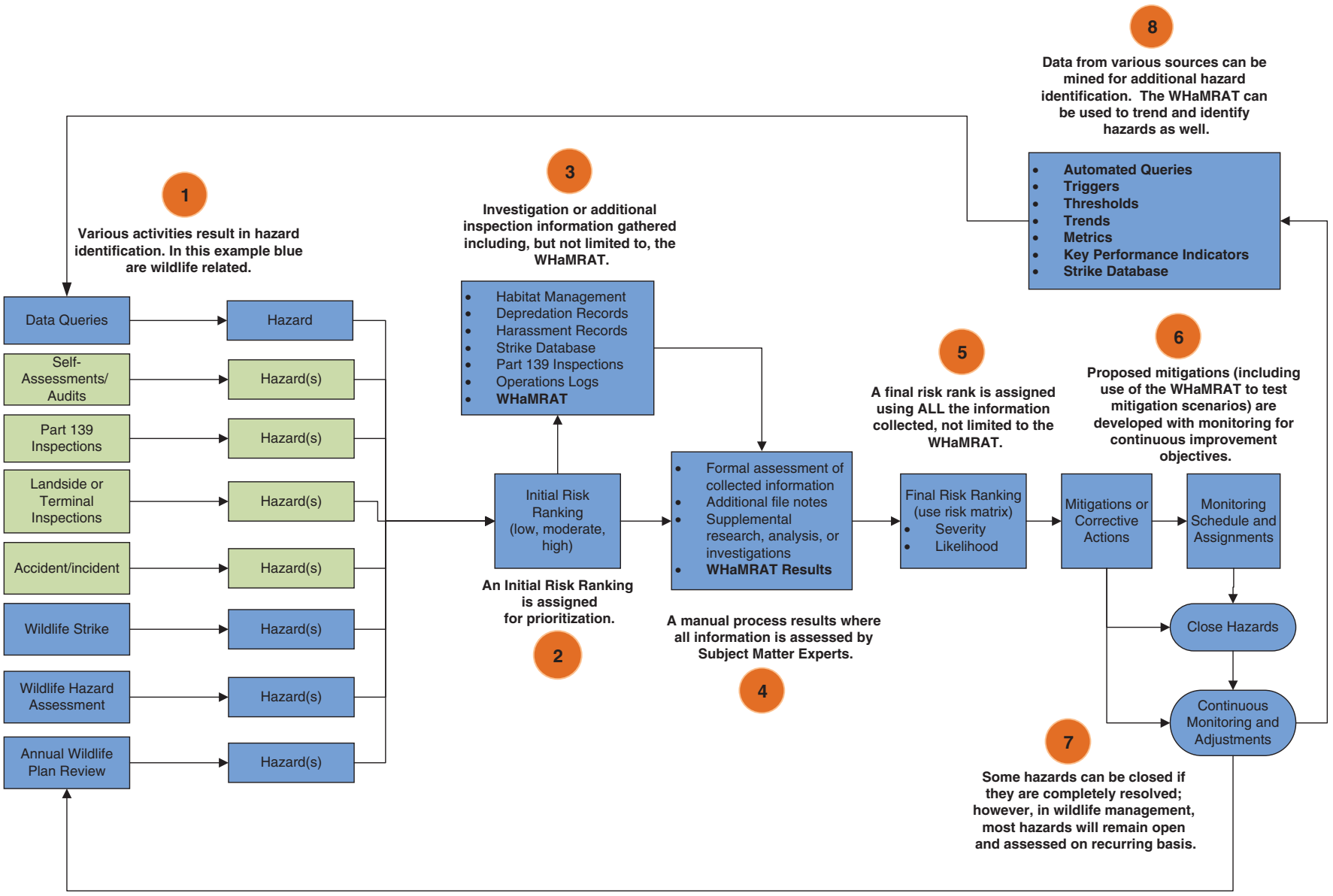
Step 1. Inputs originate from numerous sources, such as Part 139 inspections and operations logs, operational changes, construction projects, wildlife strikes, and annual WHMP reviews. Each input could trigger a hazard review based on a threshold or requirement established by the SMS or by management. The thresholds would have been identified and set up as part of the SMS, safety, or WHM program, and would be monitored by staff as carefully as possible. If more than a certain number of wildlife strikes are reported within a week, for example, a formal hazard assessment may be initiated. Establishing an electronic data or software system could assist in managing triggers and thresholds. However, a manual process also could be established through development of standard operating procedures that indicate when certain hazard assessment processes would be initiated.

Step 2. Depending on the type of wildlife hazard identified and the immediate assessment of the hazard, an initial risk rank is determined. The risk rank assists in prioritizing the hazard within the SMS, WHM, or safety program. Staff are provided guidance and instruction to quickly assess the hazard using a risk matrix similar to the example provided in Figure 4. The initial risk rank determines the next steps and the level of effort and response time required to conduct additional investigations, stop affected operations, or initiate immediate mitigations.

Step 3. As a means to further understand and manage the wildlife hazard, additional information may be collected and compiled to accurately assess the hazard and its subsequent risk rank. Additional information might include habitat management records, strike database information, operations logs, root cause analysis, data trend analysis, research, and so forth. The information gathered also can be used to begin development of specific mitigations depending on the level of urgency established by the initial risk rank and the possible effect of the hazard (i.e., the real or credible harmful outcome that has occurred or can be expected to occur if the hazard persists).

Step 4. Depending on the severity or complexity of the event, one or more types of hazard assessments may be conducted. For less complex hazards, a brief review of the findings by the wildlife, operations, or management teams would suffice. For a significant hazard (a hazard initially ranked as moderate [yellow] or high [red]), a formal Safety Risk Management Panel (SRMP) composed of experts and stakeholders may be required to ensure a certain level of technical expertise is applied to the review. The hazard review would take into consideration all information collected and would also document existing controls as a means to understand whether these controls are adequate to manage the hazard and its possible effect.

Step 5. The assessment would yield a risk ranking of each hazard; the risk rankings would then guide the mitigation choices. For example a hazard ranked as low risk (green) may not result in a new mitigation effort; but the hazard, risk ranking, and any supporting information would be retained for trending or as a means to address similar events in the future. For hazards



Source: BASH Inc.

Figure 7. Using SRM and the WHaMRAT for a Wildlife Hazard Assessment (WHA).

ranked moderate (yellow) or high (red) risk, a formal mitigation and monitoring plan would be implemented and tracked. Note that the risk ranking that results from the WHaMRAT is an Overall Aggregate Wildlife Risk Score, thus, for individual species or guild hazard assessments, a separate, manual process would need to be performed.

Steps 6 and 7. Mitigation and monitoring may include one or more actions, tasks, corrections, modifications, or controls. A mitigation plan could include staff assignments, frequency of monitoring, mitigation results review, and recording of possible new hazards originating from the implemented mitigation. If the mitigation is associated with a project (e.g., a construction project that results in increased wildlife activities), the mitigation would typically end with the project close-out. If the mitigation is part of an operational change or ongoing WHM, it may be tracked for a longer duration and less frequently or as part of the annual WHMP review. A "lessons learned" aspect of mitigation challenges and successes also could be of value for future projects and operational changes. For example, staff could research previous mitigations for valuable information to avoid repeating the development or use of solutions or mitigations that were unsuccessful. The WHaMRAT can assist wildlife and management staff to test various mitigation scenarios using the Habitat Mitigation worksheets described in Chapter 6. The Habitat Mitigation worksheets allow for current and future mitigation options and provide a risk result associated with the added, revised, or additional mitigations.

Step 8. Continuous improvement opportunities could be captured and documented by assessing existing data and information, including identified hazards, controls, mitigations, and results from the WHaMRAT. The process could be integrated into recurring WHM, SMS, or safety program reviews, assessments, or audits. This activity would allow for both proactive and reactive data analysis and allow for ongoing improvements to the program. New or additional hazards may result from the review, thus providing opportunities to continually add safety improvements to the WHM, SMS, or safety program.

CHAPTER 5

Introduction to the Wildlife Hazard Management Risk Assessment Tool (WHaMRAT)

Modeling dynamic ecosystems and wildlife populations has been conducted in various applications as described in the ecological literature. Such systems are inherently complex, which leads to uncertainties that must be accounted for when developing realistic models to describe them. The research team reviewed numerous studies for applicability to airport wildlife risk determinations; however, direct comparisons to the ACRP Project 04-17 study were not abundantly available. To develop the Wildlife Hazard Management Risk Assessment Tool (WHaMRAT), the team referenced numerous prior efforts that addressed components of wildlife risk and wildlife population modeling as well as aircraft operations applications (see Root 1988; DeFusco 1993, 1994, 1996, 1998a, 1998b, 1999, 2000, 2003, 2004; Allan 2000, 2006; Beerman and DeFusco 2001; Shamoun-Baranes et al. 2008; Paton 2010; Roberts et al. 2010).

The WHaMRAT is designed to assist airport managers in assessing the wildlife risk to aircraft operations. It is but one tool that can be used in a comprehensive wildlife management program to complement an overall Safety Management System (SMS) at an airport. The WHaMRAT's three user-input worksheets, in a spreadsheet (Microsoft Excel) format, incorporate various formulas and calculations that work together to determine an Overall Aggregate Wildlife Risk Score.

The WHaMRAT requires user inputs that account for measures of wildlife presence and abundance, monthly average aircraft movements by aircraft class, locations of habitat considered incompatible with safe aircraft operations, and current habitat and wildlife mitigation actions. These data entries produce a numerical result and graphical representation of current wildlife risk that is depicted as low, moderate, or high using a 1-to-5 scale (1 is low and 5 is high). The user also can enter optional future mitigation efforts and can view the potential impacts as Future-Projected Results. Detailed instructions on the use and interpretation of the WHaMRAT are provided in a User Guide included as Appendix C to this report.

The WHaMRAT is built on a multi-attribute decision making (MADM) framework, taking wildlife presence and the potential likelihood of wildlife strikes to determine an Overall Aggregate Wildlife Risk Score for the airport (Belton 1986, Xu 2015). User inputs for aircraft class and monthly airport operations tempo influence the overall risk score, as do adjustment factors built into the WHaMRAT to reflect the presence of habitats incompatible with aircraft operations and the effects of current and future habitat and wildlife management and control mitigation efforts (Table 1). The adjusted information is then presented visually through two risk matrices that show Wildlife Severity versus Likelihood of Strike (Figure 8) and Aggregate Wildlife Risk versus Operations Adjustment (Figure 9).

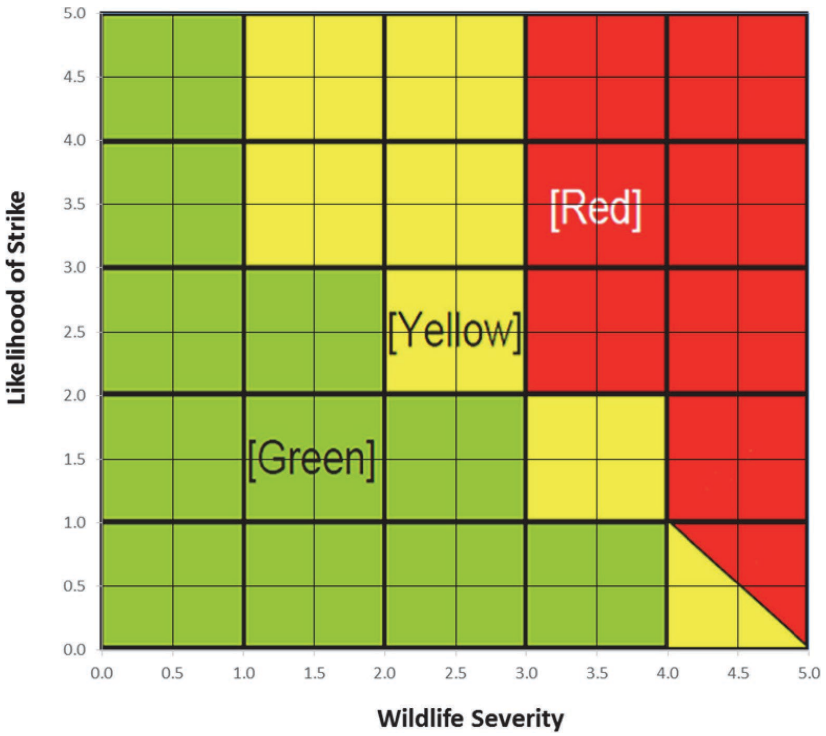
The research team developed two versions of the WHaMRAT—the EZ-Version WHaMRAT and the Advanced-Version WHaMRAT. The EZ-Version WHaMRAT allows universal application to all airport or wildlife management staff, regardless of airport size and airport operation experience. It is best practice for all airport or wildlife staff to use the EZ-Version WHaMRAT

Table 1. Data, calculations, and adjustments used to assess wildlife risk in the WHaMRAT.

Airport-Specific Data (User Inputs)		Calculations	Result
1. Wildlife	• Presence/Abundance • Group(s)/Guild(s) • Likelihood of Strike (*for each group/guild – EZ version; for each species – Advanced version)*	Baseline computation: • Likelihood of Strike x Wildlife Severity summed over all guilds (EZ version) or species (Advanced version). Modifications made for zero-tolerance species and total number of different species appearing on and surrounding the airport.	Aggregate Wildlife Risk Score
2. Operations	• Monthly Average Aircraft Operations (*for each aircraft class*)	Computation: • Scoring function based upon number of aircraft operations weighted by type of aircraft.	Operations Adjustment
3. Habitat(s) and Mitigation Effort(s)	• Presence/Absence of Incompatible Habitat(s)* and Distance(s) from the Airport** • Mitigation(s) of Incompatible Habitat(s) and Distance(s) from the Airport • Mitigation(s) of Specific Wildlife Group(s) or Guild(s)	Computation: • Habitat scoring function based upon types of incompatible habitat and distance from airport operations. • Score reduced by habitat mitigation efforts. (Wildlife mitigation affects future score only). Current wildlife mitigation efforts are used to establish baseline wildlife mitigation score, which is then modified and considered in the future Aggregate Wildlife Risk Score.	Habitat Adjustment – Mitigated ⇩ **Overall Aggregate Wildlife Risk Score**

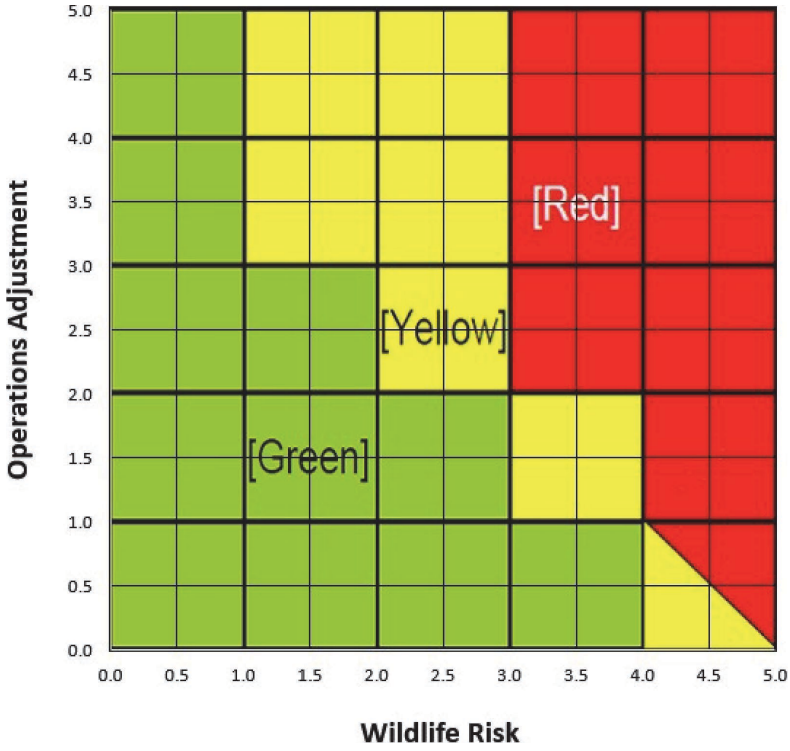
* Incompatible habitats = habitats that may attract wildlife and that have been identified as incompatible with airport operations.
** Distance(s) refer to habitat location(s), and may be categorized as being (a) on airport property/within the perimeter fence; (b) outside the perimeter fence but within 10,000-foot or 5,000-foot separation distances; (c) at distances greater than 10,000-foot or 5,000-foot separation but within 5 miles and within the air traffic pattern; (d) at distances greater than 10,000-foot or 5,000-foot separation but within 5 miles and not within the air traffic pattern; or (e) at distances greater than 5 miles but with wildlife movement potential across the airport.

For more technical information, see Attachment 10 of Appendix C.



Source: The WHaMRAT (BASH Inc.)

Figure 8. Matrix—Wildlife Severity vs. Likelihood of Strike.



Source: The WHaMRAT (BASH Inc.)

Figure 9. Matrix—Aggregate Wildlife Risk vs. Operations Adjustment.

initially. The primary difference between the two versions is the ability to further discriminate wildlife species within guilds, species presence, and associated targeted wildlife mitigation efforts in the Advanced-Version WHaMRAT.

The WHaMRAT was developed with input gathered from numerous airports from various FAA regions (Appendix A). Development airports provided input to a survey that focused on wildlife management and control combined with SMS activities. Test airports provided input on the WHaMRAT after testing the model using real-world airport data pertinent to its user-input worksheets.

CHAPTER 6

The EZ-Version WHaMRAT

This chapter provides a general overview of airport operator input into the EZ-Version WHaMRAT. The relationships between the inputs and the calculations and adjustments made in the WHaMRAT can be visualized using a flowchart (Figure 10). The basic process is the same for both the EZ-Version WHaMRAT and the Advanced-Version WHaMRAT.

6.1 The EZ-Version WHaMRAT Wildlife Data Worksheet (Severity)

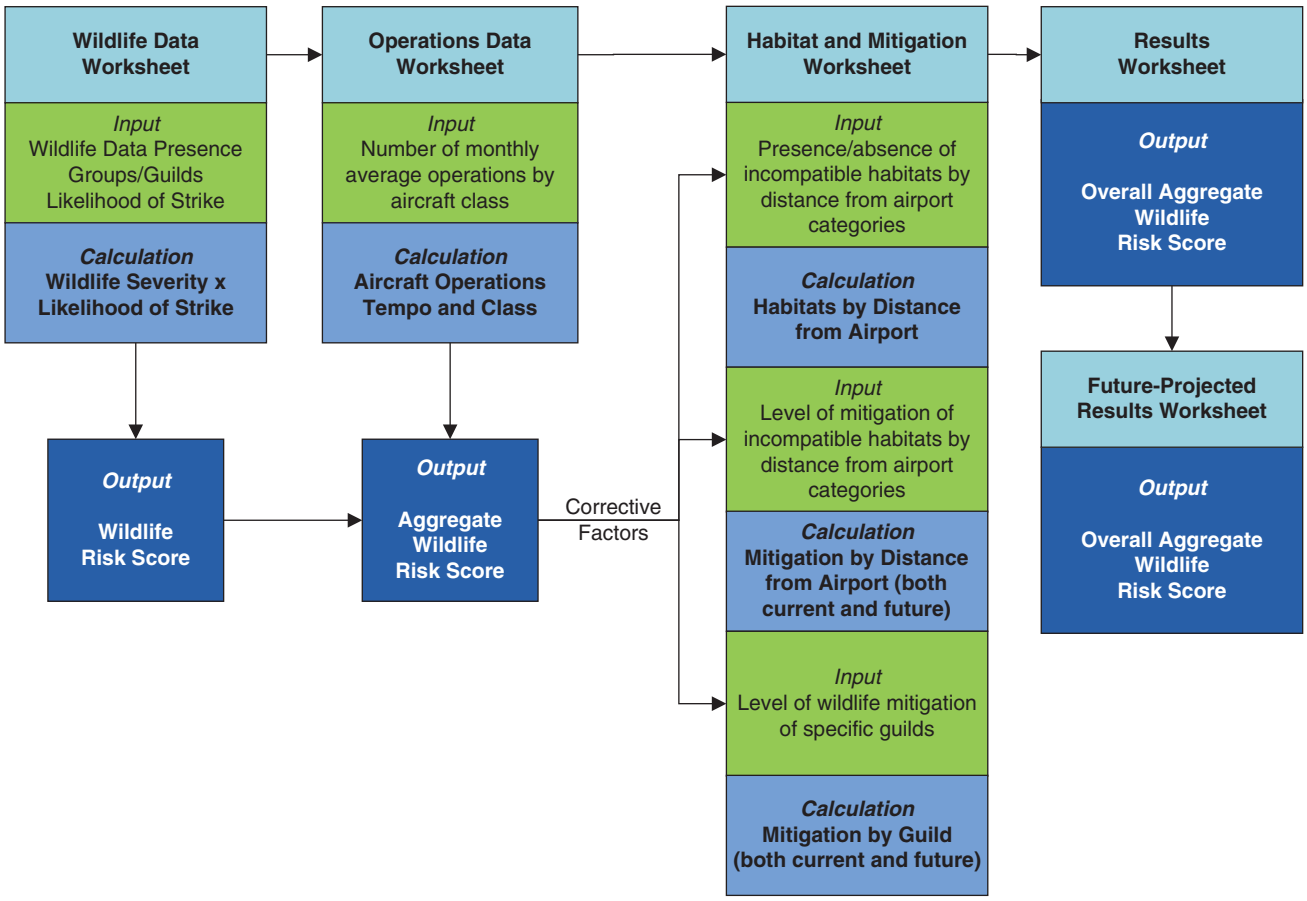
Assumptions

- *Severity × Likelihood of Strike for 1 Guild = Wildlife Risk.* The cumulative Wildlife Risk Scores of all guilds make up the Aggregate Wildlife Risk.
- Measurements of Wildlife Severity are based solely on the average body mass of each species within a specific guild. A guild may contain varied species (see Guild Designations in Attachment 1 of the User Guide, provided in this report as Appendix C). If identification of wildlife is reported at the species level, then the species must be placed in the appropriate guild by referencing Appendix C, Attachments 2, 3, 6, and 7.

Severity

For the 30 species of birds most frequently identified as struck by civil aircraft from 1990 through 2013, a strong correlation ($R^2 = 0.81$) has been documented between mean body mass and the likelihood of a strike causing damage to aircraft (Dolbeer et al. 2014). For every 100g increase in body mass, there is a 1.28% increase in the likelihood of damage. Thus, body mass is a good predictor of relative severity level among bird species.

In the WHaMRAT, the input for Wildlife Severity is an objective score ranging from 1 to 5 (using whole numbers only) and based solely on body mass (in grams) at the guild level. Guilds are defined as groups of species that exhibit common behavior, habitat use, and natural histories, but are not necessarily taxonomically related. No current consensus exists for guild designations in the avian, mammalian, or reptilian literature. Within the WHaMRAT, guild designations and associated wildlife types within each guild are detailed in the User Guide (Appendix C, Attachment 1). Because species within a particular guild may vary significantly in body mass, the body mass of each species was determined within a specific guild based on the *CRC Handbook of Avian Body Masses* (Dunning 2008) and additional average body mass reported in respected avian field guides such as *Sibley's Book of Birds* (Sibley 2000). Body masses were sorted to determine naturally occurring breaks (groups) within guilds. In addition, species presence in North America was determined using the *AOU Checklist of North and Middle American Birds* (American Ornithologists' Union 2015). This information was then cross referenced with *The Clements*



Source: BASH Inc.

Figure 10. The WHaMRAT—detailed wildlife risk assessment process.

Checklist of Birds of the World (Clements 2007) and Avibase—The World Bird Database (2015) to determine the final species listing sequences. Using this information, severity scores range from 1 (low) to 5 (high) for avian guilds. Data on body masses for mammalian and reptilian guilds were similarly defined using the *CRC Handbook for Mammalian Body Masses* (Silva and Downing 1995) and cross referenced with *Walker's Mammals of the World* (Nowak 1999a, 1999b), *Walker's Bats of the World* (Nowak 1994), and *The New Encyclopedia of Reptiles and Amphibians* (Halliday and Alder 2002). All native and introduced species recorded in North America, including Canada and all 50 United States, are included in these analyses. Many species are only extremely rarely or accidentally present, but were included nonetheless. Additional species can be expected to occur in the future as vagrants or new exotics introductions are recorded, and users may find species not present on the current list, although abundant presence on airports is not anticipated. Should new species be detected—or if users wish to analyze species from other parts of the world not presently included in this report—users can fit those species into the guild designations for analogous species in the included lists.

In the EZ-Version WHaMRAT, any species contained within a specific guild will have an identical severity score that represents the average body mass score of all species contained in that specific guild. In addition to body mass variation in some guilds, however, there is potential variation in the general guild severity score, particularly when certain species within a guild have a tendency to exhibit flocking behavior or certain species within a guild are significantly larger in mass than most individual species within a guild. To account for such variation, the WHaMRAT allows for variation in the guild severity score for Waders, Waterfowl, Shorebirds, Gulls/Terns,

Doves/Pigeons, Corvids, and Blackbirds/Starlings guilds based on different flock sizes, with severity increasing as flock sizes increase. In guilds for which flocking behavior is prevalent, a potential increase in severity due to flocking was determined by multiplying average bird mass within a specific guild by flock size and adjusting severity when threshold levels were met.

The total number of individuals necessary to reach severity scores of 4 or 5 based on body mass was used to determine flock size by specific guild. In the Waterfowl Guild, flock size thresholds varied from < 5 to ≥ 5, whereas in much smaller birds, such as those found in the Blackbirds/Starlings Guild, flock size thresholds are either < 100 or ≥ 100 individuals to influence a change in severity scores. In the Upland Game Birds Guild, an increase in guild severity score occurs only if Wild Turkeys are present. Because Wild Turkeys are significantly larger in body mass than most representatives of the Upland Game Birds Guild, it is necessary to increase the severity score if Wild Turkeys are present. Avian Wildlife Severity Scores that include a flocking adjustment to severity scores at the guild level are detailed in Table 2.

Table 2. The EZ-Version WHaMRAT avian guilds and severity scores.

Weights expressed in grams (g)

Guilds	Severity
Waterbirds	2
Seabirds	2
Pelicans/Cormorants	4
Waders	2
If flocks ≥ 5	5
Waterfowl	3
If flocks < 5	4
If flocks ≥ 5	5
Raptors/Vultures/Owls	2
Upland Game Birds	2
If Turkeys	5
Cranes	5
Shorebirds	1
If flocks < 15	4
If flocks ≥ 15	5
Gulls/Terns	2
If flocks < 10	4
If flocks ≥ 10	5
Pigeons/Doves	1
If flocks < 20	4
If flocks ≥ 20	5
Parrots	1
Aerial Foragers	1
Woodland Birds	1
Corvids	2
If flocks < 10	4
If flocks ≥ 10	5
Grassland Birds	1
Blackbirds/Starlings	1
If flocks < 100	4
If flocks ≥ 100	5
Miscellaneous	1
Criteria for Score	**Severity**
Less than 300g	1
300–999g	2
1000–1999g	3
2000–3999g	4
Greater than 4000g	5

Source: BASH Inc.

Table 3. The EZ-Version WHaMRAT mammalian and reptilian guilds and severity scores.

Weights expressed in grams (g)

Guilds	Severity
Rodents	2
Lagomorphs	4
Bats	1
Mesomammals	4
Canids	5
Felids	5
Hooved	5
Bears	5
Turtles	2
Iguanas	2
Lizards/Snakes	2
Crocodiles/Alligators	5
Criteria for Score	**Severity**
0–99g	1
100–599g	2
600–1999g	3
2000–9999g	4
Greater than 10000g	5

Source: BASH Inc.

When determining severity for mammals and reptiles, the process was identical to the avian description detailed above. However, threshold levels for severity by body mass for mammals and reptiles vary significantly from those for avian guilds, as aircraft will only encounter these animals (with the exception of bats) on the ground, and aircraft components that can be struck are less vulnerable to damage. Mammalian and reptilian Wildlife Severity Scores at the guild level are detailed in Table 3.

6.2 The EZ-Version WHaMRAT Wildlife Data Worksheet (Likelihood of Strike)

Assumptions

- *Severity × Likelihood of Strike for 1 Guild = Wildlife Risk.* The cumulative Wildlife Risk Scores of all guilds make up the Aggregate Wildlife Risk.
- Wildlife Likelihood of Strike is based solely on estimates of abundance determined by objective wildlife observations contained in Wildlife Hazard Assessments (WHAs), Wildlife Hazard Site Visits (WHSVs), or reference documents.

Likelihood of Strike

Likelihood of Wildlife Strike is a user-determined score based solely on an objective estimate of abundance of a particular wildlife species relative to airport operating surfaces. No consideration for the size of the wildlife present should be given when determining likelihood, as body mass is already accounted for in the severity index. In the WHaMRAT, users will determine the likelihood value for each guild previously identified in the severity tables based on estimated

Table 4. Scoring likelihood of wildlife strike by abundance of species.

Species Abundance	Likelihood Score
Not present	0 (or left blank)
Rare	1
Uncommon	2
Fairly common	3
Common	4
Abundant	5

abundance data by species and/or guild reported in a WHA or WHSV, or obtained from other local data sources. If such data do not exist, then the wildlife presence and likelihood values should be determined using abundance data from wildlife identification field guides or handbooks, or via Internet sources such as the USGS Northern Prairie Wildlife Research Center (USGS 2015). Most wildlife identification handbooks include information on range and seasonal presence of species, including observation rankings from "rare" to "abundant." The USGS Northern Prairie Wildlife Research Center also provides species lists and observation rankings for numerous wildlife refuges, wildlife areas, and so forth that may be in close proximity to a given airport. Airport operators could extrapolate such data sources to make an educated estimate of species/guild presence and estimated abundance for their particular location by season. Table 4 shows the likelihood scores that are recommended to be input when using referenced sources that provide abundance information.

6.3 The EZ-Version WHaMRAT Operations Data Worksheet

Assumptions

- An adjustment factor to the initial Aggregate Wildlife Risk Score is applied based on the number of average monthly aircraft movements as compared to the average monthly aircraft movements in airports across the United States. This adjustment becomes a component of the Overall Aggregate Wildlife Risk Score.
- The Operations Adjustment factor applied to the Aggregate Wildlife Risk Score accounts for monthly aircraft operations and aircraft class susceptibility to damage. (Note: The average number of aircraft operations at airports across the United States is taken from the FAA's Air Traffic Activity Data System (ATADS) that contains the official NAS air traffic operations data.)

Operations

The Operations Data Worksheet calculates the risk associated with airport operations given the amount of monthly aircraft operations and the class of aircraft movements/operations at an airport. In ATADS, airports report four classes of aircraft movements to FAA: commercial, air taxi, general aviation, and military. In the WHaMRAT, a fifth class—Rotary Wing—is included, resulting in five classes requiring user inputs in this worksheet. Thus, the EZ-Version WHaMRAT is designed to accept input of the number of monthly aircraft movements broken down as follows:

- **Commercial:** An aircraft with a seating capacity of more than 60 seats or a maximum payload capacity of more than 18,000 pounds carrying passengers or cargo for hire or compensation (itinerant and local).

- **Air Taxi:** An aircraft originally designed to have no more than 60 passenger seats or a cargo payload of 18,000 pounds and carries cargo or mail on either a scheduled or charter basis, and/or carries passengers on an on-demand basis or limited-schedule basis (i.e., on four or fewer round trips a week on at least one route according to published flight schedules) only.
- **General Aviation:** All civil aircraft, except those classified as air carriers/commercial or air taxis.
- **Military:** All military aircraft, turboprop and jet (itinerant and local).
- **Rotary:** An aircraft that uses lift generated by wings/rotors that rotate around a vertical axis or mast.

The Operations Data Worksheet calculates the risk associated with airport operations given the amount of monthly aircraft operations and the class of aircraft movements/operations at the airport. To establish a comparative benchmark of operations, the average monthly aircraft operations by aircraft class were determined for 551 civil airports with the largest number of operations in the ATADS database. Operations and aircraft class tempo were used as the benchmark for establishing the corrective factor for a specific airport's operations in calculating the Wildlife Risk Score.

Once users have input the operations data by aircraft class, this value is compared to the average operations benchmark to determine the degree of the multiplicative adjustment factor on the Aggregate Wildlife Risk Score that was determined in the Wildlife Data Worksheet. If an airport has greater than average monthly operations, the resulting adjustment will increase wildlife risk; if the airport has less than average monthly operations, the adjustment will result in a decreased wildlife risk.

In general, as airport operations increase, the probability of a wildlife strike increases; however, this increase is not linear but an arc-tangent function. Thus, as operations reach high values, the rate of increase of a possible wildlife strike decreases with increased operations.

Each aircraft class is weighed differently in the calculation based on the aircraft class susceptibility to damage. The susceptibility weighting factor was determined by examining the FAA Wildlife Strike Database to determine damage levels recorded by various aircraft categories when exposed to strikes with similar wildlife species.

In addition to user input into the current airport monthly operations by aircraft class, an additional user input into future airport monthly operations is available to determine the effect of planned increases or decreases in monthly air operations. Having input predicted future monthly airport operations, the user can project the effects of changes in airport operations relative to the Aggregate Wildlife Risk Score.

6.4 The EZ-Version WHaMRAT Habitat and Mitigation Worksheet

Assumptions

- An adjustment factor is applied to the Aggregate Wildlife Risk Score based on the cumulative presence or absence of habitats that are incompatible with aircraft operations. This adjustment becomes a component of the Overall Aggregate Wildlife Risk Score.
- The effect on wildlife risk decreases as the distance from the airport property increases.
- Mitigation efforts are effective and reduce the impact of incompatible habitat.

Habitat Presence or Absence

The Habitat and Mitigation Worksheet is designed to identify those habitats that are considered incompatible with airport operations, and the WHaMRAT accounts for those habitats

identified in FAA AC 150/5200-33B. The user identifies the current presence or absence of such habitats by placing an *x* in the appropriate habitat row specific to a column indicating its location relative to the airport property. The Habitat and Mitigation Worksheet lists specific habitats, but users also can add up to three user-defined habitats unique to their situation that may attract wildlife and therefore should be accounted for and considered. These additional habitats are identified as "User-defined."

Specific incompatible habitats listed in the WHaMRAT include:

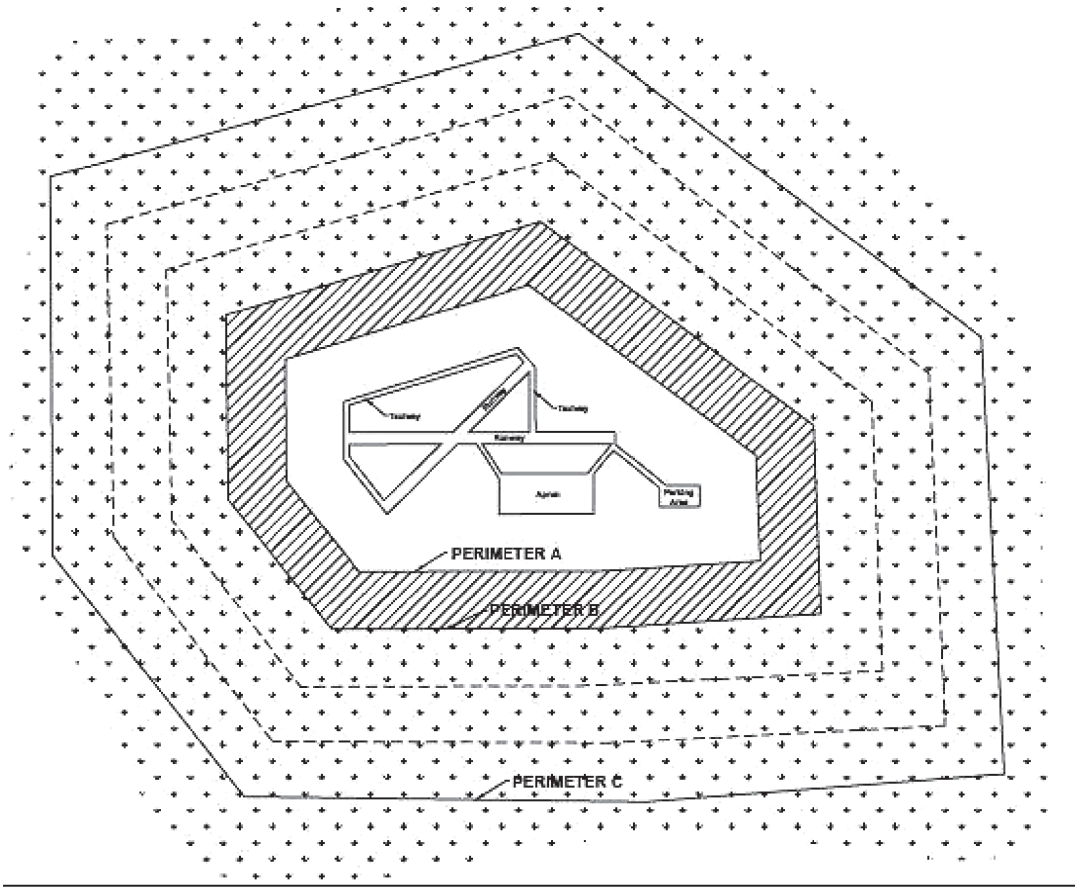
- Solid waste open landfill.
- Enclosed trash transfer.
- Composting operations.
- Underwater waste discharge.
- Stormwater collection.
- Wastewater treatment facility.
- Artificial marsh.
- Natural wetlands.
- Agricultural crops.
- Livestock production.
- Aquaculture.
- Golf courses.
- Woodlands/forests.
- Landscaping.
- Synergistic effects of authorized uses.
- User-defined #1.
- User-defined #2.
- User-defined #3.

The user input also allows for the identification of habitat presence at varying distances from the airport property. These distances account for (1) FAA separation criteria of 5,000 feet (airports serving piston-driven aircraft), 10,000 feet (airports serving turbofan-driven aircraft), and 5 miles, as identified in FAA AC 150/5200-33B (Figure 11), and (2) the landfill separation criteria identified in FAA AC 150/5200-34A. Each habitat distance location from the airport is weighted differently in a decreasing decay function as the habitat is located farther from the airport property. Thus, incompatible habitats at greater distances from the airport property have less effect on the adjustment factor applied to the Aggregate Wildlife Risk Score. Specific distance categories included in the WHaMRAT are:

- On airport property, within the perimeter fence.
- Outside the perimeter fence but within 10,000-foot or 5,000-foot separation distances.
- At distances greater than 10,000-foot or 5,000-foot separation but within 5 miles, and in the traffic pattern.
- At distances greater than 10,000-foot or 5,000-foot separation but within 5 miles and not in the traffic pattern.
- Greater than 5 miles but there is wildlife movement potential across airport.

Current Habitat Mitigation—Assumptions

- An adjustment factor to the Aggregate Wildlife Risk Score is applied in the WHaMRAT based on the cumulative level of current habitat mitigation practices specific to habitats that are incompatible with aircraft operations. This adjustment becomes a component of the Overall Aggregate Wildlife Risk Score.



PERIMETER A: For airports serving piston-powered aircraft, hazardous wildlife attractants must be 5,000 feet from the nearest air operations area.

PERIMETER B: For airports serving turbine-powered aircraft, hazardous wildlife attractants must be 10,000 feet from the nearest air operations area.

PERIMETER C: 5-mile range to protect approach, departure and circling airspace.

Source: FAA AC 150/5200-33B

Figure 11. Separation criteria.

- The effect on wildlife risk decreases as a decay function when the distance from the airport property increases.
- Increases in habitat mitigation will decrease wildlife risk, whereas decreases in habitat mitigation will increase wildlife risk.

Current Habitat Mitigation

Once the user has identified all incompatible habitats, inputs are added about the habitat mitigation efforts associated with these habitats. If an airport is performing some form of mitigation associated with a specific habitat, the user inputs low (1), moderate (2), or high (3) for the level of mitigation currently in place. These data inputs should include all habitats identified for all locations relative to the airport. Habitat mitigation outside of airport properties often is difficult and non-jurisdictional. Thus, the inputs for current habitat mitigation at increasing distances from the airport may be none (0) or left blank in the user input.

Future Habitat Mitigation—Assumptions

- An adjustment factor to the Aggregate Wildlife Risk Score is applied in the WHaMRAT based on the cumulative level of documented habitat mitigation practices specific to habitats that are incompatible with aircraft operations. This adjustment can be used to determine a future-projected Overall Aggregate Wildlife Risk Score.
- The effect on wildlife risk decreases as a decay function when the distance from the airport property increases.
- Increases in habitat mitigation will decrease wildlife risk, while decreases in habitat mitigation will increase wildlife risk.

Future Habitat Mitigation

The WHaMRAT offers users the option to input and evaluate future habitat mitigation efforts. This input is not necessary for the WHaMRAT to perform functions related to current mitigation efforts. The process used to input data for future habitat mitigation is identical to the process used for current habitat mitigation. However, users can account for increases or decreases in planned future habitat mitigation efforts associated with a particular habitat and location relative to the airport property and evaluate its effect.

In summary, the user input into habitats and associated habitat mitigation efforts allows users to evaluate both current and future habitat mitigation effect on wildlife risk, based on habitat attraction and relative distance from the airport.

Wildlife Mitigation by Guilds—Assumptions

- An adjustment factor to the Aggregate Wildlife Risk Score is applied based on the cumulative level of current and future wildlife mitigation practices specific to wildlife guilds that are present and identified in the Wildlife Data Worksheet. This adjustment can be used to determine a future-projected Overall Aggregate Wildlife Risk Score.
- One specific technique or method of wildlife mitigation may affect more than one guild. A combination of wildlife mitigation techniques or methods results in higher levels of wildlife mitigation for a specific guild.
- Increases in wildlife mitigation will decrease wildlife risk, whereas decreases in wildlife mitigation will increase wildlife risk.
- Current wildlife abundance is measured with current guild mitigation efforts in place. Therefore, current mitigations of certain guilds will not change the current wildlife score. However, input of current mitigation levels against those guilds is required to correctly assess the impact of future mitigation efforts.
- Future mitigation efforts should be at least at the same levels as current mitigation efforts. Failure to maintain current mitigation levels and failure to input the level of mitigation into the future guild mitigation column will increase the Overall Aggregate Wildlife Risk Score.

Current and Future Mitigation by Guilds

Users can input wildlife mitigation efforts targeted at specific wildlife species or guilds. As with the habitat mitigation input, users can input both current and future wildlife mitigation effort levels (low, moderate, or high) specific to a targeted guild. Airport staff or wildlife staff have numerous wildlife management and control options available. Many of these options are specific to a target species or guild; however, many other options are less specific to a particular species or guild and may affect several guilds. One example of such a mitigation option is maintaining turf at recommended heights of 6–12 inches. The managed turf height is effective on many guilds.

Turf management, combined with additional measures (ranging from non-lethal harassment and deterrence to lethal options), can have a synergistic effect on wildlife control mitigation and substantiate user-input values of moderate and/or high when all wildlife control and mitigation measures are taken into account. By allowing users to input levels for both current and future wildlife mitigation efforts by guild, the WHaMRAT lets users evaluate potential future wildlife mitigation efforts and prioritize wildlife mitigation targeted at problem species/guilds.

The goal for the EZ-Version WHaMRAT is to allow for universal application by all airport or wildlife staff, regardless of airport size, operations tempo, and wildlife management and control experience. The research team believes the best practice is for all airport or wildlife staff to use the EZ-Version WHaMRAT initially. The EZ-Version WHaMRAT provides valuable information and utility to all airports and provides a quantitative wildlife risk-based assessment of current and future scenarios for all users. The Advanced-Version WHaMRAT is available if a more experienced user desires more detailed user data input and potential evaluation capabilities.

CHAPTER 7

The Advanced-Version WHaMRAT

This chapter provides a general overview of airport operator input into the Advanced-Version WHaMRAT.

7.1 The Advanced-Version WHaMRAT Wildlife Data Worksheet (Severity)

Assumptions

- *Severity × Likelihood of Strike for 1 Guild = Wildlife Risk.* The cumulative wildlife risk of all guilds is the Aggregate Wildlife Risk.
- Wildlife Severity is based solely on average body mass of each species within a specific guild. Guilds contain varied species that are detailed in Guild Designations in the User Guide (Appendix C, Attachment 1). Within each guild, there are five potential categories that are based on ranges of body mass in species within each guild listed in the User Guide (Appendix C, Attachments 4 and 5).
- Users identify species that are present, and those species are then placed into a specific mass range category within each guild.

Severity

Identical to the EZ-Version WHaMRAT, the user input for Wildlife Severity in the Advanced-Version WHaMRAT is an objective score (ranging from 1 to 5) based solely on body mass (measured in grams) at the guild level. Because each guild may contain species with widely ranging body mass, this variation is accounted for by allowing users to input Wildlife Severity data based on the presence of a particular species or combination of species within a guild.

The body mass of each avian species within a specific guild was determined based on the *CRC Handbook of Avian Body Masses* (Dunning 2008) and additional average body mass reported in respected avian field guides such as *Sibley's Book of Birds* (Sibley 2000). Data on body masses for mammalian and reptilian guilds were similarly defined using the *CRC Handbook for Mammalian Body Masses* (Silva and Downing 1995) and cross referenced with *Walker's Mammals of the World* (Nowak 1999a, 1999b), *Walker's Bats of the World* (Nowak 1994), and *The New Encyclopedia of Reptiles and Amphibians* (Halliday and Alder 2002). Each guild was sorted by body mass to determine naturally occurring breaks (groups) in body mass within a particular guild. This information enabled the research team to determine up to five body mass groups (categories) within a specific guild.

Because each body mass category within each guild represents a varying severity level ranging from 1 (low) to 5 (high), species-level data are provided by input of the species into a body mass

category within each guild. The WHaMRAT assigns a severity score to each avian, mammalian, and reptilian species based on the appropriate five body mass groups within the specific guild as detailed in Table 5 and Table 6.

Within each guild, each species and body mass category has an assigned severity score. Guild designations and the associated severity score assigned to each species are detailed in the User Guide (Appendix C, Attachments 4, 5, 8, and 9).

To input data for Wildlife Severity in the Advanced-Version WHaMRAT, users first identify each particular species or combination of species within a particular guild. Because each species is included in a specific body mass group within each guild, that species is represented by a guild categorized by a specific body mass range. For example, in the Waterfowl Guild, if an airport has

Table 5. Advanced-Version WHaMRAT, avian guilds and severity scores.

Weights expressed in grams (g)

Guild	Severity
Waterbirds	
Waterbirds < 300g	1
Waterbirds 300–999g	2
Waterbirds 1000–1999g	3
Waterbirds 2000–3999g	4
Waterbirds > 4000g	5
Seabirds	
Seabirds < 300g	1
Seabirds 300–999g	2
Seabirds 1000–1999g	3
Seabirds 2000–3999g	4
Pelicans/Cormorants	
Pelicans 1000–1999g	3
Pelicans 2000–3999g	4
Pelicans > 4000g	5
Waders	
If flocks ≥ 5	5
Waders 300–999g	2
Waders 1000–1999g	3
Waders 2000–3999g	4
Waders > 4000g	5
Waterfowl	
If flocks < 5	4
If flocks ≥ 5	5
Waterfowl 300–999g	2
Waterfowl 1000–1999g	3
Waterfowl 2000–3999g	4
Waterfowl > 4000g	5
Raptors/Vultures/Owls	
Raptors < 300g	1
Raptors 300–999g	2
Raptors 1000–1999g	3
Raptors 2000–3999g	4
Raptors > 4000g	5
Upland Game Birds	
Upland Game Birds < 300g	1
Upland Game Birds 300–999g	2
Upland Game Birds 1000–1999g	3
Upland Game Birds 2000–3999g	4
Upland Game Birds > 4000g	5
Cranes	5

Guild	Severity
Shorebirds	
If flocks < 20	4
If flocks ≥ 20	5
Shorebirds < 300g	1
Shorebirds 300–999g	2
Gulls/Terns	
If flocks < 10	4
If flocks ≥ 10	5
Gulls/Terns < 300g	1
Gulls/Terns 300–999g	2
Gulls/Terns 1000–1999g	3
Pigeons/Doves	
If flocks < 20	4
If flocks ≥ 20	5
Pigeons/Doves < 300g	1
Pigeons/Doves 300–999g	2
Parrots	
Parrots < 300g	1
Parrots 300–999g	2
Parrots 1000–3999g	3
Aerial Foragers	1
Woodland Birds	1
Corvids	
If flocks < 15	4
If flocks ≥ 15	5
Corvids < 300g	1
Corvids 300–999g	2
Corvids 1000–1999g	3
Grassland Birds	1
Blackbirds/Starlings	1
If flocks < 100	4
If flocks ≥ 100	5
Miscellaneous	
Miscellaneous < 300g	1
Miscellaneous 300–999g	2
Criteria for Score	**Severity**
Less than 300g	1
300–999g	2
1000–1999g	3
2000–3999g	4
Greater than 4000g	5

Source: BASH Inc.

Table 6. Advanced-Version WHaMRAT, mammalian and reptilian guilds and severity scores.

Weights expressed in grams (g)

Guild	Severity
Rodents	
Rodents < 100g	**1**
Rodents 100–599g	**2**
Rodents 600–1999g	**3**
Rodents 2000–9999g	**4**
Rodents > 10000g	**5**
Lagomorphs	
Lagomorphs 100–599g	**2**
Lagomorphs 2000–9999g	**4**
Bats	
Bats < 100g	**1**
Bats 100–600g	**2**
Mesomammals	
Mesomammals 100–599g	**2**
Mesomammals 600–1999g	**3**
Mesomammals 2000–9999g	**4**
Mesomammals > 10000g	**5**
Canids	
Canids 2000–9999g	**4**
Canids > 10000g	**5**
Felids	
Felids 600–1999g	**3**
Felids > 10000g	**5**
Hooved	
Hooved > 10000g	**5**
Bears	
Bears > 10000g	**5**
Criteria for Score	**Severity**
0–99g	**1**
100–599g	**2**
600–1999g	**3**
2000–9999g	**4**
Greater than 10000g	**5**

Source: BASH Inc.

Green-winged Teal, Blue-winged Teal, and Wood Ducks on the airport, each of these species has a severity score of 2 based on body mass and is accounted for by the Waterfowl Guild 300–999g category. If the same airport also has Canada Geese (severity score of 4) under the Waterfowl Guild 2000–3999g category and Tundra Swans (severity score of 5) under the Waterfowl Guild > 4000g category, the user would also input these species into their respective guild categories to accurately account for all waterfowl on the airport.

In guilds for which flocking behavior is prevalent, a potential increase in severity due to flocking is accounted for by multiplying average bird mass within the guild by a varying number of individuals until a severity score based on body mass of 4 or 5 is reached. Thus in the Waterfowl Guild, flock sizes of < 5 or ≥ 5 are used, while for much smaller birds (such as those found in the

Blackbirds/Starlings Guild), flock size is either < 100 or ≥ 100 individuals to influence a change in severity scores. In the Upland Game Birds Guild, an increase in guild severity score occurs only if Wild Turkeys are present. Because Wild Turkeys are significantly larger in body mass than most representatives of this guild, it is necessary to increase the severity score if Wild Turkeys are present. The next section details the process to adjust avian Wildlife Severity Scores at the guild level to include flocking adjustment to severity scores.

7.2 The Advanced-Version WHaMRAT Wildlife Data Worksheet (Likelihood of Strike)

Likelihood of Wildlife Strike—Assumptions

- *Severity × Likelihood of Strike for 1 Guild = Wildlife Risk.* The cumulative wildlife risk of all guilds is the Aggregate Wildlife Risk.
- Wildlife Likelihood of Strike is based on estimates of abundance derived from objective wildlife observations contained in WHAs, WHSVs, or reference documents.

Likelihood of Wildlife Strike

Likelihood of Wildlife Strike is a user-determined score based solely on the objective estimate of abundance of a particular wildlife species relative to airport operating surfaces. No consideration should be given to the size of the wildlife present in the likelihood index, as that is already accounted for in the severity index. Users can determine the likelihood value for each guild and/or species previously identified for the severity user input based on estimated abundance data by guild and/or species reported in a WHA, WHSV, or in published literature. If such data do not exist, then the severity and likelihood value should be determined using abundance data from wildlife identification field guides or handbooks, or via Internet sources such as the USGS Northern Prairie Wildlife Research Center (USGS 2015). Most wildlife identification handbooks include information on range and seasonal presence of species, including observation rankings from "rare" to "abundant." The USGS Northern Prairie Wildlife Research Center also provides species lists and observation rankings for numerous wildlife refuges, wildlife areas, and so forth that may be in close proximity to a particular airport. Airport operators could extrapolate such data sources to make an educated estimate of species/guild presence and estimated abundance for their particular location and season. Table 7 shows the likelihood scores that are recommended to be input when using referenced sources that provide abundance information.

It cannot be overstated that the effectiveness of the WHaMRAT is predicated by appropriate assignments of Wildlife Severity and Likelihood of Strike scores. The cumulative effect

Table 7. Scoring likelihood of wildlife strike by abundance of species.

Species Abundance	Likelihood Score
Not present	0 (or left blank)
Rare	1
Uncommon	2
Fairly common	3
Common	4
Abundant	5

of the Aggregate Wildlife Severity and Likelihood of Strike scores input into the WHaMRAT by users determines the airport's initial or current state Aggregate Wildlife Risk Score (ranging from 1 to 5). The remaining user inputs into subsequent worksheets in the WHaMRAT merely result in multiplicative adjustment factors and effects on this initial Aggregate Wildlife Risk Score that may result in an increase, decrease, or no effect on this Aggregate Wildlife Risk Score.

7.3 The Advanced-Version WHaMRAT Operations Data Worksheet

Assumptions

- An adjustment factor to the initial Aggregate Wildlife Risk Score is applied based on the number of average monthly aircraft movements as compared to the average monthly aircraft movements in airports across the United States. (The average number of aircraft operations at airports across the United States is taken from the FAA's Air Traffic Activity Data System (ATADS) that contains the official NAS air traffic operations data.)
- The Operations Adjustment factor applied to the Aggregate Wildlife Risk Score accounts for monthly aircraft operations and aircraft class susceptibility to damage. This adjustment becomes a component of the Overall Aggregate Wildlife Risk Score.

Operations

By necessity, the process of user input to the Operations Data Worksheet in the Advanced-Version WHaMRAT is identical to that in the EZ-Version WHaMRAT.

7.4 The Advanced-Version WHaMRAT Habitat and Mitigation Worksheet

Habitat Presence or Absence and Mitigation—Assumptions

- An adjustment factor to the Aggregate Wildlife Risk Score is applied based on the cumulative level of current habitat presence or absence specific to habitats that are incompatible with aircraft operations. This adjustment becomes a component of the Overall Aggregate Wildlife Risk Score.
- The effect on wildlife risk decreases as the distance from the airport property increases.
- Mitigation efforts are effective and reduce the impact of incompatible habitat.
- Increases in habitat mitigation will decrease wildlife risk, whereas decreases in habitat mitigation will increase wildlife risk.
- If a habitat has been completely mitigated, such as filling in a natural wetland, then that habitat no longer exists, and an *x* should NOT be placed in that habitat row/column.

Current and Future Habitat Presence or Absence and Mitigation

The Habitat and Mitigation Worksheet in the Advanced-Version WHaMRAT is identical to that in the EZ-Version WHaMRAT. An identical approach to input habitat data is necessary. In addition, the current and future mitigation user-input worksheet associated with habitat is also identical in both versions of the WHaMRAT. However, the Advanced-Version WHaMRAT is different from the EZ-Version WHaMRAT in user input for current and future wildlife mitigation targeted at specific guilds.

Wildlife Mitigation by Guilds—Assumptions

- An adjustment factor to the Aggregate Wildlife Risk Score is applied based on the cumulative level of current and future wildlife mitigation specific to guilds that are present and have been identified in the Wildlife Data Worksheet. This adjustment becomes a component of the Overall Aggregate Wildlife Risk Score.
- One specific technique or method of wildlife mitigation may affect more than one guild. A combination of wildlife mitigation techniques or methods results in higher levels of wildlife mitigation for a specific guild.
- Wildlife mitigation techniques targeted at a particular species will be reflected in the user input with the associated guild category based on a specific body mass range.
- Increases in mitigation will decrease wildlife risk, whereas decreases in mitigation will increase wildlife risk.

Current and Future Wildlife Mitigation by Guilds

The primary difference between the two versions of the WHaMRAT is the ability in the Advanced-Version WHaMRAT to further discriminate wildlife mitigation efforts at the guild level. Specifically,

- In the EZ-Version WHaMRAT, a guild includes all species in a particular guild with the average body mass in that guild used to determine severity and the associated severity score. The user then inputs current and future wildlife mitigation values based on these more generalized guilds.
- In the Advanced-Version WHaMRAT, each guild is further divided into categories that encompass body mass ranges in the guild, and this design results in greater discrimination within that guild. As a result, the user can input current and future wildlife mitigation efforts that may be targeted at species that fall within a specific body mass range category in each guild.

7.5 Utility of the WHaMRAT

The Results and Future-Projected Results output worksheets of both versions of the WHaMRAT provide airport or wildlife staff with a comprehensive and accurate representation of wildlife risk based on Wildlife Severity and abundance, monthly aircraft operations tempo, and susceptibility to damage from wildlife strikes by aircraft class, potential habitat attraction at varying distances from the airport, and current and future wildlife management and control mitigation associated with habitat and wildlife. Prioritization and application of future wildlife control and management mitigation should account for the current state of affairs while pursuing the goal of continuous reduction in wildlife risk. If mitigation is effective, then the net result should be a decrease in wildlife species/guilds present, combined with an associated reduction in the likelihood of wildlife strikes.

A depiction of changes in Overall Aggregate Wildlife Risk can be derived from the model output, and data from periodic entries into the WHaMRAT should be used at the individual airport level for trend analysis over time. Regardless of any single Overall Aggregate Wildlife Risk Score obtained from the WHaMRAT—whether it be low (green), moderate (yellow), or high (red)—the ultimate goal of all airport or wildlife staff is to continuously "drive the dot down and to the left" by reducing its Overall Aggregate Wildlife Risk Score. This continuous process associated with the WHaMRAT is the essence of a Safety Management System (SMS).

CHAPTER 8

Case Study Examples

Section 3.0 of the User Guide (Appendix C) provides eight case studies that detail how the WHaMRAT responds to various situations that airport or wildlife staff may encounter. Case Studies #1 through #7 apply to both the EZ-Version WHaMRAT and the Advanced-Version WHaMRAT. Case Study #8 is specific only to the Advanced-Version WHaMRAT. Situations covered in the case studies are:

- **Case Study #1—**Seasonal flocking behavior.
- **Case Study #2—**Changes in guilds present.
- **Case Study #3—**Change in airport operations tempo.
- **Case Study #4—**Change in incompatible habitat on- or off-airport.
- **Case Study #5—**Change in habitat mitigation on airport property.
- **Case Study #6—**Change in wildlife mitigation targeted at a specific guild.
- **Case Study #7—**Change in wildlife mitigation on airport infrastructure.
- **Case Study #8—**User input of wildlife identified at the species level (only in the Advanced-Version WHaMRAT).

CHAPTER 9

Conclusions and Suggested Research

9.1 Conclusions

Safety Management Systems (SMSs) and Wildlife hazard management (WHM) programs are easily integrated; both are founded on formal processes and documentation that

- Assess risk through a Safety Risk Management (SRM) component.
- Develop controls and mitigations, and review data and results on an ongoing basis through a Safety Assurance component.

Incorporation of the Safety Policy and Safety Promotion components of the SMS supports the WHM program through management commitments, safety objectives, training, and communication. The effort to integrate the two initiatives is a natural progression to improved safety that is founded on quality data and analysis, and that emphasizes prioritized, preventive mitigations that are reassessed on a recurring basis in a continuous improvement process.

ACRP Project 04-17 was initiated to help start the process of integrating airport WHM programs into their larger SMS processes. An integral part of that integration process is to provide a standardized means of determining risk levels for various hazardous wildlife species that pose safety and economic costs to airport and aircraft operations. Although many tools are available to objectively and subjectively determine risk as part of each airport's continuous improvement processes, a core of this project was the development of a tool to assist in those efforts. The research team produced the Wildlife Hazard Management Risk Assessment Tool (WHaMRAT) as a key component of that process. The WHaMRAT models wildlife and aircraft operations together with the airport environment and mitigation efforts to determine an Overall Aggregate Wildlife Risk Score that can be used to determine the current state of the wildlife risk at each airport, and importantly, can be used over time for trending analysis as a data feedback mechanism in the continuous improvement process as is the goal of the overall SMS. The team made every effort to remove subjectivity in the model inputs and behavior and provide airports with an empirical and objective means of measuring progress in their WHM programs. The very nature of wildlife behavior and the means by which wildlife data is collected and reported on airports make complete objectivity impossible to determine, but if standard protocols and data entry procedures are followed, the model can be used with consistent bias to provide valuable current state and trending information in an adaptive management strategy. This tool can be used as an important component of airport WHM programs and is a perfect fit with an airport's SMS.

9.2 Suggested Research

The research team believes that additional research would be helpful to more accurately quantify wildlife risk on airports. Wildlife Risk (commonly applied as Wildlife Severity × Likelihood of Strike) is extremely difficult to completely and objectively quantify because of the numerous applications and variables involved.

There is a growing understanding in aviation that wildlife strike severity is best represented by body mass because it is influential in determining the potential for damage to aircraft when wildlife strikes occur. Unfortunately, the interchangeable use of the terms *severity* and *hazard* is commonplace in aviation, which can lead to potential confusion. Severity is most influenced by the magnitude of the hazard, not merely by its presence. The team suggests a universal application of Wildlife Severity that incorporates an index of body mass as the primary factor in determining aviation risk.

A similar concern affects the use of the word *risk.* Again, the terms *hazard* and *risk* are commonly and improperly used interchangeably, leading to further confusion of terminology in the aviation industry. As universally accepted and as applied to this project, *risk* is the combination of the presence of a hazard and the likelihood of its being encountered. The magnitude of the risk, or its relative impact, is further determined by the severity of the encountered hazard.

The likelihood of encountering a potential hazard continues to be the most difficult parameter to objectively measure, in particular when addressing highly variable conditions such as the presence and abundance of wildlife. Determining the likelihood of a wildlife strike is extremely complicated. This factor is strongly influenced by objective measures of wildlife abundance; however, other confounding factors such as behavior, proximity to airport operating surfaces, and temporal variation, make definite determinations of actual Likelihood of Strike difficult. In addition, data derived from wildlife strikes recorded in the FAA Wildlife Strike Database are highly valuable, but are most likely incomplete and highly variable, as seen in differences in reporting rates and data collection methodologies of Part 139-certificated versus general aviation airports. Research to develop tools, methodologies, and/or technologies to reduce subjectivity and create more objective assessments of strike likelihoods would be of great help. These can include more rigorous ecological data collection protocols on airports and even the use of remotely sensed data to reduce the inherent bias in current determinations of wildlife presence and abundance on and around airports. Research and analysis of strike data and risk assessment protocols are strongly suggested to address these disparities and to ensure a common terminology is used when discussing aviation risk.

In developing the WHaMRAT, the team attempted to best account for Severity and Likelihood of Strikes in the most objective manner possible given data and analysis constraints. However, more details are most likely necessary for each variable and should be further evaluated. In addition, further testing of this model is necessary for user airports to confirm its functionality, validity, application, and accuracy using real-world data over a period of time greater than this initial effort and from a much larger number of airports that represent both FAA 139-certificated and general aviation airports throughout all FAA regions. It is further suggested that follow-on research be conducted on the actual implementation of the model once it is fielded and tested in such operational environments.

An added benefit of future research would be to conduct a similar test of the WHaMRAT as part of an airport's formal, implemented SMS and as part of airports' requirements to annually assess their WHM Plans (WHMPs) and WHM programs. The test would assess whether using tools such as the WHaMRAT in conjunction with a manual or automated SRM process would be compatible or would create confusion or inaccuracies in risk assessments and adaptive management strategies.

A significant future research opportunity for data management and sharing would be to develop a web-based interface for airport data entry. The species lists by guild and severity data in the WHaMRAT, as detailed in the relevant attachments in the User Guide (Appendix C) could serve as a means to supplement the FAA Wildlife Strike Database, including future opportunities to trend data from one system to the other. The ability to collect detailed data would certainly assist in future proactive and predictive analysis specific to mitigation measures.

Glossary

SMS-relevant Terms

Causes Actions, omissions, events, conditions, or a combination thereof, that led to the accident or incident. Events that result in a hazard or failure are causes; causes can occur by themselves or in combinations.

Consequence(s) The projected end result(s) or outcome(s) of a hazard, including their likelihood and severity. A consequence is presented numerically as a position within a risk matrix. The end result provides the user with a current-state indicator of wildlife management. The projection takes into account number of operations, abundance, size, and other factors. In some industries, consequence can be used as a synonym for severity; however, ICAO and FAA have not used the term consequence as a standard for severity.

Control Anything that mitigates the risk of a hazard's effect. As with safety requirements, all controls must be written in requirements language. The three types of controls are: (1) *validated* controls, which are unambiguous, correct, complete, and verifiable; (2) *verified* controls, which have been objectively determined to meet the design solution; and (3) *recommended* controls, which have the potential to mitigate a hazard or risk but are not yet validated as part of the system or its requirements.

Credible A specific system state and sequence of events, supported by data and expert opinion, which clearly describes the outcome. In an SMS, *credible* implies that it is reasonable to expect the assumed combination of extreme conditions will occur within the operational lifetime of the system.

Effect A real or credible harmful outcome that has occurred or can be expected to occur if the hazard occurs in the defined system state. A single hazard can have multiple effects.

Existing control Something already in place that mitigates the risk of a hazard's effect. An existing control must be documented with supporting data and a rationale that confirms the control's use, applicability, and availability related to the hazard. For example, if orders are identified as existing controls, the specific version, paragraph, and/or section number(s) should be cited. Alternatively, if equipment is identified as a control, documentation should discuss how the equipment mitigates or manages the risk.

Hazard Any existing or potential condition that can lead to injury, illness, or death to people; damage to or loss of a system, equipment, or property; or damage to the environment. A hazard is a condition that is a prerequisite of an accident or incident. A hazard might or might not result in a situation of high risk.

Hazard assessment A systematic, comprehensive evaluation of a change, operation, system, or safety issue.

Incident An occurrence, other than an accident, which is associated with the operation of an aircraft and which affects or could affect the safety of operations as defined in 49 CFR 830.2.

Likelihood The estimated probability or frequency of a hazard's effect. Likelihood may be described in quantitative or qualitative terms.

National Airspace System (NAS) The common network of U.S. airspace; air navigation facilities; equipment and services; airports or landing areas; aeronautical charts and information services; rules, regulations, and procedures; technical information; and labor and material. The NAS includes system components shared with the military.

National Plan of Integrated Airport Systems (NPIAS) The national airport system plan developed by the office of the U.S. Secretary of Transportation on a biannual basis for the development of public-use airports to meet national air transportation needs.

Risk The composite of predicted severity and likelihood of the potential effect of a hazard in the worst credible system state. The three types of risk are: (1) initial risk, referring to the predicted severity and likelihood of a hazard when it is first identified and assessed, including the effects of preexisting risk controls in the current environment; (2) current risk, referring to the predicted severity and likelihood of a hazard at the current time; and (3) residual risk, referring to the predicted risk that remains after all risk mitigations have been implemented or exhausted and all risk mitigations have been verified.

Risk analysis The process during which a hazard is characterized for its likelihood and the severity of its effect or harm. Risk analysis can be either quantitative or qualitative; however, the inability to quantify or the lack of historical data on a particular hazard does not preclude the need for analysis.

Risk assessment 1. The process by which the results of risk analysis are used to make decisions. 2. The process of combining the impacts of risk elements discovered in risk analysis and comparing them against some acceptability criteria. Risk assessment can include consolidating risks into risk sets that can be jointly mitigated, combined, and then used in decision making.

Risk matrix (predictive) A graphical depiction of the various levels of severity and likelihood as they relate to the levels of risk (e.g., low, moderate, or high). On a typical risk matrix, severity and likelihood are placed on opposing axes (i.e., *x*-axis and *y*-axis) on a grid. A higher severity would be plotted farther to the right on the *x*-axis, and a higher likelihood would be plotted farther up the *y*-axis.

Risk mitigation Anything that mitigates the risk of a hazard's effect.

Safety A condition in which the risk of harm or damage is limited to an acceptable level.

Safety Assessment (SA) A process used to identify, analyze, and document hazards and safety issues, including, as applicable, a formal five-step process culminating in documentation of the findings of a Safety Risk Management (SRM) panel. Also called *safety risk assessment* (SRA). SA/SRA documentation describes the identified hazards or current safety issues, presents proposed changes, and presents evidence supporting whether the proposed changes or mitigation strategies are acceptable from a safety risk perspective.

Safety Assurance A set of continuous process-management functions used to evaluate the effectiveness of implemented risk mitigation strategies, support the identification of new hazards, and systematically provide confidence that an organization meets or exceeds its safety objectives through continuous improvement.

Safety Management System (SMS) A formal approach to managing safety through creation and development of (1) an organization-wide Safety Policy; (2) formal methods of Safety Risk Management (SRM) used to identify hazards and analyze and mitigate risk; (3) methods of

Safety Assurance through continuous safety improvement; and (4) strategies for organization-wide Safety Promotion. As the foundational component of the SMS, the Safety Policy documents the airport's means of deploying the system. SRM and SA are the two operational components of the SMS. Safety Promotion encompasses all three of the other components by ensuring that individuals with a role in SMS are properly trained and that safety issues identified through any of the activities associated with the components are communicated. Working together, the four components of the SMS provide management with a set of decision-making tools with which to plan, organize, direct, and control business activities in a manner that enhances safety and ensures compliance with regulatory standards. These tools are similar to those management already uses to make production or operations decisions.

Safety objectives Measurable goals or desirable outcomes related to safety.

Safety Policy Safety Policy provides the foundation or framework for the SMS. It outlines the methods and tools for achieving desired safety outcomes. The Safety Policy also details management's responsibility and accountability for safety.

Safety Promotion Safety Promotion encompasses the processes and procedures used to create an environment in which safety objectives can be achieved. Safety Promotion is essential to a positive *safety culture,* which is characterized by knowledge and understanding of the organization's SMS, effective communications, competency in job responsibilities, ongoing training, and information sharing. Safety Promotion elements include training programs, communication of critical safety issues, and confidential reporting systems.

Safety Risk Management (SRM) 1. A generic term that encompasses the assessment and mitigation of the safety risks and the consequences of hazards that threaten the capabilities of an organization, to a level as low as is reasonably practicable. The objective of SRM is to provide the foundations for a balanced allocation of resources among all assessed safety risks and those safety risks for which control and mitigation are viable. 2. A formal process within the Safety Management System (SMS) composed of (a) describing the system, (b) identifying the hazards, and (c) assessing, analyzing, and controlling the risk. The SRM process is embedded in the operational system; it is not a separate/distinct process.

Safety Risk Management Panel (SRMP) A group formed to formalize a proactive approach to system safety using a methodology that ensures hazards are identified and unacceptable risk is mitigated before changes are made. The SRMP provides a framework to ensure that once a change is made, it will be tracked throughout its life cycle.

Safety risk mitigation Anything that mitigates the safety risk of a hazard. Safety risk controls necessary to mitigate an unacceptable risk should be mandatory, measurable, and monitored for effectiveness.

Safety risk probability The likelihood that a safety consequence or outcome might occur, expressed as an estimated frequency.

Severity The measure of how extreme the results of a consequence or outcome are predicted to be. Severity is determined by the worst credible outcome.

System An integrated set of constituent pieces that are combined in an operational or support environment to meet a defined objective. These pieces include people, equipment, information, procedures, facilities, services, and other support services.

Wildlife-relevant Terms

Air operations area (AOA) All airport areas where aircraft can operate, either under their own power or while in tow. The AOA includes runways, taxiways, and apron areas.

Canid Describes species associated with the dog family, including coyotes, foxes, wolves, and domestic/feral dogs.

Felid Describes species associated with the cat family, including mountain lions, lynxes, bobcats, and domestic/feral cats.

Feral animal A domestic animal reverted to living in the wild; also includes strays.

Guild Groups of species in a community that exploit the same set of resources in a similar manner, but that are not necessarily closely related taxonomically.

Habitat The environment where an animal lives.

Lagomorphs Species such as rabbits, hares, and relatives.

Mesomammals Intermediate-sized mammals of several unrelated families (e.g., raccoons, skunks, armadillos, opossums).

Migratory birds Bird species for which at least part of the population migrates between breeding and wintering grounds.

Qualified Airport Wildlife Biologists (QAWBs) Airport personnel trained and experienced in biology under the guidelines specified in FAA Advisory Circular 150/5200-36A.

Wildlife control personnel Airport personnel trained and equipped to respond to wildlife hazards on the airfield.

Wildlife Hazard Assessment (WHA) A formal study conducted to determine baseline wildlife populations on and around airports; a WHA is normally conducted over a 12-month period as per FAA guidelines.

Wildlife Hazard Management Plan (WHMP) A document that implements a wildlife mitigation program at an airport as directed by federal regulations and FAA guidelines.

Wildlife Hazard Site Visit (WHSV) A truncated version of a Wildlife Hazard Assessment (WHA), conducted over a shorter period of time to determine if more extensive study is required per FAA guidelines.

Wildlife Hazard Working Group (WHWG) A committee formed to monitor and implement the Wildlife Hazard Management Plan (WHMP) and program.

Abbreviations

AC	Advisory circular
AGL	Above ground level
AIP	Airport Improvement Program
AOA	Air operations area
AOU	American Ornithologists' Union
ARP	FAA Airport Division/Line of Business
ATADS	Air Traffic Activity Data System
ATC	air traffic control
CFR	(U.S.) Code of Federal Regulations
EZ	Easy
FAR	Federal Aviation Regulation
FOD	Foreign object damage
FOIA	Freedom of Information Act
GA	General aviation
ICAO	International Civil Aviation Organization
KPI	Key performance indicator
MADM	Multi-attribute decision making
MBTA	Migratory Bird Treaty Act
NAS	National Airspace System
NPIAS	National Plan of Integrated Airport Systems
Part 139	Title 14 Code of Federal Regulations (CFR) Part 139
QAWB	Qualified airport wildlife biologist
SA	Safety Assessment
SMICG	Safety Management International Collaboration Group
SMS	Safety Management System
SOP	Standard operating procedure
SRA	Safety Risk Assessment
SRM	Safety Risk Management
SRMP	Safety Risk Management Panel
USDA	United States Department of Agriculture
USGS	United States Geological Survey
WHA	**W**ildlife Hazard Assessment
WHaMRAT	Wildlife Hazard Management Risk Assessment Tool
WHM	**W**ildlife hazard management
WHMP	Wildlife Hazard Management Plan
WHSV	**W**ildlife Hazard Site Visit
WHWG	**W**ildlife Hazard Working Group

References

Airports Council International. *Aerodrome Bird Hazard Prevention and Wildlife Management Handbook*, 1st ed. Geneva, Switzerland, 2005.

Allan, J. R. A Protocol for Bird Strike Risk Assessment at Airports. Presented at Conference of the International Bird Strike Committee, Amsterdam, Netherlands, 2000.

Allan, J. R. A Heuristic Risk Assessment Technique for Birdstrike Management at Airports. *Risk Analysis*, Vol. 26, 2006, pp. 723–729.

Allan, J., A. Orosz, A. Badham, and J. Bell. The Development of Birdstrike Risk Assessment Procedures, Their Use on Airports, and the Potential Benefits to the Aviation Industry. Presented at Conference of the International Bird Strike Committee, Warsaw, Poland, May 5–9, 2003.

Allerton, K., A. Johnson, J. Lengel, M. Knecht, D. Seal, P. Esposito, and G. Griffin. *ACRP Report 125: Balancing Airport Stormwater and Bird Hazard Management.* Transportation Research Board of the National Academies, Washington, D.C., 2015.

American Ornithologists' Union. Checklist of North and Middle American Birds. Available at: http://checklist.aou.org/taxa/ (accessed May, 30 2015).

Avibase. Avibase—Bird Checklists of the World North America (US/Can). Available at: http://avibase.bsc-eoc.org/checklist.jsp?region=na1&list=clements (accessed May 30, 2015).

Ayres Jr., M., H. Shirazi, S. Cardoso, J. Brown, et al. *ACRP Report 1: Safety Management Systems for Airports, Volume 2: Guidebook.* Transportation Research Board of the National Academies, Washington, D.C., 2009.

Bannard, D. Y. *ACRP Legal Research Digest 19: Legal Issues Related to Developing Safety Management Systems and Safety Risk Management at U.S. Airports.* Transportation Research Board of the National Academies, Washington, D.C., 2013.

Beermann, T., M. Bobo, and R. P. DeFusco. Enhancements to the United States Bird Avoidance Model (US BAM). Presented at Conference of the Bird Strike Committee USA/Canada 3. Calgary, Alberta, Canada, August 27–30, 2001.

Belant, J. L., and C. R. Ayers. *ACRP Synthesis 52: Habitat Management to Deter Wildlife at Airports.* Transportation Research Board of the National Academies, Washington, D.C., 2014.

Belant, J. L., and J. A. Martin. *ACRP Synthesis 23: Bird Harassment, Repellent, and Deterrent Techniques for Use on and Near Airports, A Synthesis of Airport Practice.* Transportation Research Board of the National Academies, Washington, D.C., 2011.

Belton, V. A Comparison of the Analytic Hierarchy Process and a Simple Multi-Attribute Value Function. *European Journal of Operational Research*, Vol. 25, 1986, pp. 7–21.

Bennett, P. M., and I. P. F. Owens. *Evolutionary Ecology of Birds.* Oxford University Press, 2008.

Bicudo, J. E., W. A. Buttemer, M. A. Chappell, J. T. Pearson, and C. Bech. *Ecological and Environmental Physiology of Birds.* Oxford University Press, 2010.

Biondi, K. M., J. L. Belant, J. A. Martin, T. L. DeVault, and G. Wang. White-tailed Deer Incidents with U. S. Civil Aircraft. *Wildlife Society Bulletin*, Vol. 35, 2010, pp. 303–309.

Blokpoel, H. *Bird Hazards to Aircraft.* Books Canada, Inc., Buffalo, NY, 1976.

Bolen, E. G., and W. L. Robinson. *Wildlife Ecology and Management*, 5th ed. Pearson Benjamin Cummings, San Francisco, CA, 2003.

Both, I., H. van Gasteren, and A. Dekker. A Quantified Species-Specific Bird Hazard Index. Presented at Conference of the International Bird Strike Committee, Cairns, Australia, September 20–24, 2010.

Civil Aviation Authority. *Wildlife Hazard Management at Aerodromes* (CAP 733), London, UK, 2014.

Civil Aviation Safety Authority. Strike One: Wildlife Is it a Bird or a Plane? No, it's a Flying Fox. *Flight Safety Australia*, March–April, 2011, pp. 9–14.

Code of Federal Regulations (50 CFR 21.43). Depredation Order for Blackbirds, Cowbirds, Grackles, Crows and Magpies. Available at: http://www.gpo.gov/fdsys/granule/CFR-2009-title50-vol6/CFR-2009-title50-vol6-sec21-43.

Cleary, E. C., and A. Dickey. *ACRP Report 32: Guidebook for Addressing Aircraft/Wildlife Hazards at General Aviation Airports.* Transportation Research Board of the National Academies, Washington, D.C., 2010.

Cleary, E. C., and R. A. Dolbeer. *Wildlife Hazard Management at Airports: A Manual for Airport Personnel.* Federal Aviation Administration, Washington, D.C., 1999.

Clements, J. F. *The Clements Checklist of Birds of the World*, 6th ed., Cornell University Press, NY, 2007.

Crossley, R. *The Crossley ID Guide*, Princeton University Press, NJ, 2010.

DeFusco, R. P. Modeling Bird Hazards to Aircraft: A Geographic Information System Application Study. *Photogrammetric Engineering and Remote Sensing*, Vol. 59, 1993, pp. 1481–1487.

DeFusco, R. P. Environmental Factors Influencing Turkey Vulture Distribution and Abundance: A Geographic Information System Application Study. PhD Dissertation, University of Colorado, Boulder, CO, 1994.

DeFusco, R. P. Using Geographic Information Systems to Model Bird Distributions and Populations on a Continental Scale. Presented at Conference of the International Bird Strike Committee, London, UK, 1996.

DeFusco, R. P. Introducing the New BAM. *Flying Safety Magazine*, Vol. 54, 1998a, pp. 4–5.

DeFusco, R. P. The U.S. Air Force Bird Avoidance Model. Presented at Vertebrate Pest Conference, Costa Mesa, CA, 1998b.

DeFusco, R. P. The United States Bird Avoidance Model (BAM), in: Y. Leshem, Y. Mandelik, J. Shamoun-Baranes (eds.). *International Seminar on Birds and Flight Safety in the Middle East*, Tel Aviv, Israel, 1999, pp. 241–243.

DeFusco, R. P. Current Status of the USAF Bird Avoidance Model (BAM). Presented at Conference of the International Bird Strike Committee, Amsterdam, Netherlands, 2000.

DeFusco, R. P. Avoiding Birds in the 21st Century. *Flying Safety Magazine*, Vol. 59, 2003, pp. 16–17.

DeFusco, R. P. and W. Ruhe, BAM Comes to Alaska. *Flying Safety Magazine*, Vol. 60, 2004, pp. 4–7.

DeFusco, R. P., and E. T. Unangst, *ACRP Synthesis 39: Airport Wildlife Population Management*, Transportation Research Board of the National Academies, Washington, D.C., 2013.

DeVault, T. L., J. E. Kubel, D. J. Glista, and O. E. Rhodes. Mammalian Hazards at Small Airports in Indiana: Impact of Perimeter Fencing. *Human-Wildlife Conflicts*, Vol. 2, 2008, pp. 240–247.

Dillingham, G. L. *Improved Data Quality and Analysis Capabilities are Needed as FAA Plans a Risk-Based Approach to Safety Oversight.* U.S. Government Accountability Office, Washington D.C., 2011.

Dillingham, G. L. *Additional Oversight Planning by FAA Could Enhance Safety Risk Management.* U.S. Government Accountability Office, Washington, D.C., 2014.

Dolbeer, R. A. Population Dynamics: The Foundation of Wildlife Damage Management for the 21st Century. Paper 9:1-11 in *Proceedings of the Eighteenth Vertebrate Pest Conference*, Costa Mesa, Calif., March 2–5, 1998.

Dolbeer, R. A. Height Distribution of Birds Recorded by Collisions with Civil Aircraft. *Journal of Wildlife Management*, Vol. 70, 2006, pp. 1345–1350.

Dolbeer, R. A. Birds and Aircraft—Fighting for Airspace in Ever More Crowded Skies. *Human-Wildlife Conflicts*, Vol. 3, 2009, pp. 165–166.

Dolbeer, R. A. Increasing Trend of Damaging Bird Strikes with Aircraft Outside the Airport Boundary: Implications for Mitigation Measures. *Human-Wildlife Interactions*, Vol. 5, 2011, pp. 235–248.

Dolbeer, R. A., and S. E. Wright. Safety Management Systems: How Useful Will the FAA National Wildlife Strike Database Be? *Human-Wildlife Conflicts*, Vol. 3, 2009, pp. 167–178.

Dolbeer, R. A., S. E. Wright, and E. C. Cleary. Ranking the Hazard Level of Wildlife Species to Aviation. *Wildlife Society Bulletin*, Vol. 28, 2000, pp. 372–378.

Dolbeer, R. A., S. E. Wright, J. Weller, and M. J. Begier. *Wildlife Strikes to Civil Aircraft in the United States, 1990–2013.* Office of Airport Safety and Standards, Federal Aviation Administration, U.S. Department of Transportation, Washington, D.C., 2014.

Dukiya, J., and V. Gahlot. An Evaluation of the Effect of Bird Strikes on Flight Safety Operations at International Airport. *International Journal for Traffic and Transport Engineering*, Vol. 3(1), 2012, pp. 1–18.

Dunning, J. B. *CRC Handbook of Avian Body Masses*, 2d ed. CRC Press, NY, 2008.

Federal Aviation Administration. Airport Safety and Standards. CertAlert No. 97-09, *Wildlife Hazard Management Plan Outline,* 1997.

Federal Aviation Administration. Airport Safety and Standards. CertAlert No. 98-05, *Grasses Attractive to Hazardous Wildlife,* 1998.

Federal Aviation Administration. Airport Safety and Standards. CertAlert No. 04-16, *Deer Hazard to Aircraft and Deer Fencing,* 2004a.

Federal Aviation Administration. Airport Safety and Standards. CertAlert No. 04-09, *Relationship between FAA and Wildlife Services,* 2004b.

Federal Aviation Administration. Airport Safety and Standards. AC 150/5200-34A, *Construction or Establishment of Landfills near Public Airports,* 2006a.

Federal Aviation Administration. Airport Safety and Standards. CertAlert No. 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,* 2006b.
Federal Aviation Administration. Airport Safety and Standards. AC 150/5200-33B, *Hazardous Wildlife Attractants on or Near Airports,* 2007.
Federal Aviation Administration. Airport Safety and Standards. CertAlert No. 08-01, *Notices to Airmen (NOTAMs) for Airport Operators,* 2008.
Federal Aviation Administration. Airport Safety and Standards. Document Number FAA-2010-0997-0074, *Airport Safety Management Systems Pilot Studies,* 2010.
Federal Aviation Administration. Airport Safety and Standards. *External SMS Efforts, Part 139 Rulemaking, Airport SMS Pilot Studies,* 2011a.
Federal Aviation Administration. Airport Technology Research and Development Branch. *Overview of the Wildlife Strike Problem,* 2011b.
Federal Aviation Administration. Airport Safety and Standards. AC 150/5200-37A, *Draft Introduction to Safety Management Systems for Airport Operators,* 2012a.
Federal Aviation Administration. Airport Safety and Standards. AC 150/5200-36A, *Qualifications for Wildlife Biologist Conducting Wildlife Hazard Assessments and Training Curriculums for Airport Personnel Involved in Controlling Wildlife Hazards on Airports,* 2012b.
Federal Aviation Administration. Airport Safety and Standards. CertAlert No. 13-01, *Federal and State Depredation Permit Assistance,* 2013a.
Federal Aviation Administration. Airport Safety and Standards. AC 150/5200-32B, Reporting Wildlife Aircraft Strikes, 2013b.
Federal Aviation Administration. Airport Safety and Standards. Draft AC 150/5200-XX Protocol for the Conduct and Review of Wildlife Hazard Site Visits, Wildlife Hazard Assessments, and Wildlife Hazard Management Plans. Available at http://www.faa.gov/documentLibrary/media/Advisory_Circular/draft_150_5200_XX_wildlife.pdf.
Federal Aviation Administration. FAA Order 8000.369A, Safety Management System Guidance, 2013c.
Federal Aviation Administration. Airport Sponsor Assurances. (March 2014). Federal Aviation Administration, Washington, D.C. Available at http://www.faa.gov/airports/aip/grant_assurances/media/airport-sponsor-assurances-aip.pdf.
Federal Aviation Administration. Airport Safety and Standards. AC 150/5200-38, Draft Protocol for the Conduct and Review of Wildlife Hazard Site Visits, Wildlife Hazard Assessments, and Wildlife Hazard Management Plans, 2014a.
Federal Aviation Administration. FAA Order 5100.38D, *Airport Improvement Program (AIP) Handbook*, 2014b.
Feldhamer, G. A., B. C. Thompson, and J. A. Chapman. *Wild Mammals of North America.* 2nd ed. Johns Hopkins University Press, 2003.
Felices, H. *Overview of the Airport Safety Data Program.* Federal Aviation Administration, U.S. Department of Transportation, Hershey, PA, 2009.
Halliday, T., and K. Alder. *The New Encyclopedia of Reptiles and Amphibians.* Oxford University Press, 2002.
Hazel, R., J. Blais, T. Browne, and D. Benzon. *ACRP Report 19A: Resource Guide to Airport Performance Indicators.* Transportation Research Board of the National Academies, Washington, D.C., 2011.
Hygnstrom, S. E., R. M. Timm, and G. E. Larson. *Prevention and Control of Wildlife Damage.* University of Nebraska–Lincoln, 1994.
Infrastructure Management Group, Inc., The Performance Institute, and Counter Technology Incorporated. *ACRP Report 19: Developing an Airport Performance-Measurement System.* Transportation Research Board of the National Academies, Washington, D.C., 2010.
International Birdstrike Committee. Recommended Practices No. 1, *Standards for Aerodrome Bird/Wildlife Control*, Issue 1 (October 2006), pp. 1–19.
International Civil Aviation Organization. *Safety Management Manual (SMM)*, 3rd ed., Montreal, QC, Canada, 2013a.
International Civil Aviation Organization. *Safety Management Annex 19*, 1st ed., Montreal, QC, Canada, 2013b.
Krausman, P. R. *Introduction to Wildlife Management.* Prentice Hall, Upper Saddle River, NJ, 2002.
Linnell, M. A., M. R. Conover, and T. J. Ohashi. Analysis of Bird Strikes at a Tropical Airport. *Journal of Wildlife Management*, Vol. 60, 1996, pp. 935–945.
Linnell, M. A., M. R. Conover, and T. J. Ohashi. Biases in Bird Strike Statistics Based on Pilot Reports. *Journal of Wildlife Management*, Vol. 63, 1999, pp. 997–1003.
Ludwig, D., et al. *ACRP Report 1: Safety Management Systems for Airports, Volume 1: Overview.* Transportation Research Board of the National Academies, Washington, D.C., 2007.
MacDonald, D. W. *The Encyclopedia of Mammals.* Facts on File Press, NY, 1987.
MacDonald, D. W. *The Princeton Encyclopedia of Mammals.* Princeton University Press, NJ, 2006.

MacKinnon, B. R., R. Sowden, and S. Dudley. *Sharing The Skies, an Aviation Industry Guide to the Management of Wildlife Hazards.* Transport Canada, Ottawa, ON, Canada, 2001.

Martin, J. A., et al. Wildlife Risk to Aviation: A Multi-Scale Issue Requires a Multi-Scale Solution, *Human-Wildlife Interactions*, Vol. 5, 2011, pp. 198–203.

Njå, O., et al. *Risk of Bird Strikes, A Discussion of Current Tools and Practices.* University of Stavanger, Stavangar, Norway, 2012.

Nowak, R. M. *Walker's Bats of the World.* Johns Hopkins University Press, MD, 1994.

Nowak, R. M. *Walker's Mammals of the World, 6th ed.*, Vol. 1. Johns Hopkins University Press, MD, 1999a.

Nowak, R. M. *Walker's Mammals of the World, 6th ed.*, Vol. 2. Johns Hopkins University Press, MD, 1999b.

Ntampakis, D., and T. Biermann. Applying SMS and Sustainability Principles to Airport Wildlife Hazard Management. *Revista Conexão Sipaer*, Vol. 5, 2014, pp. 8–21.

Paton, D. C. *Bird Risk Assessment Model for Airports and Aerodromes, Revision 3.* University of Adelaide, Adelaide, Australia, 2010.

Perrins, C. *The Princeton Encyclopedia of Birds.* Princeton University Press, NJ, 2009.

Peurach, S. C., C. J. Dove, and L. Stepko. A Decade of U.S. Air Force Bat Strikes. *Human-Wildlife Conflicts*, Vol. 3, 2009, pp. 199–207.

Roberts, C. L., et al. Applying GIS and Relative Hazard Scores to Produce a Meaningful Wildlife Hazard Assessment. Presented at Bird Strike Committee USA/Canada 12, Salt Lake City, UT, 2010.

Root, T. *Atlas of Wintering North American Birds: An Analysis of Christmas Bird Count Data.* University of Chicago Press, IL, 1988.

Ruhe, W. Bird Avoidance Models vs. Realtime Birdstrike Warning Systems—A Comparison. International Birdstrike Committee, IBSC27/WPX-3, 2005.

Safety Management International Collaboration Group. *Risk Based Decision Making Principles*, 2013.

Safety Management System for Certificated Airports. Docket No. FAA-2010-0997, Notice No. 10–14, RIN 2120–AJ38. 75 Fed. Reg. 62008 (October 7, 2010).

Scott, G. *Essential Ornithology.* Oxford University Press, Oxford, England, 2010.

Shamoun-Baranes, J., W. et al. Avian Information Systems: Developing Web-Based Bird Avoidance Models. *Journal of Ecology and Society*, Vol. 13, 2008, p. 38.

Sibley, D. A. *The Sibley Guide to Birds.* Audubon Society Nature Guides, Knopf Inc., NY, 2000.

Silva, M., and J. A. Downing. *CRC Handbook of Mammalian Body Masses.* CRC Press, NY, 1995.

Sinclair, A. R. E., J. M. Fryxell, and G. Caughley. *Wildlife Ecology, Conservation, and Management*, 2nd ed. Blackwell, Malden, MA, 2006.

Sowden, R., T. Kelly, and S. Dudley. Airport Bird Hazard Risk Assessment Process. Presented at 9th Annual Bird Strike Committee, Kingston, ON, Canada, 2007.

Stocking, C., et al. *ACRP Report 13: Integrating Airport Information Systems.* Transportation Research Board of the National Academies, Washington, D.C., 2009.

Transport Canada. *Wildlife Control Procedures Manual (TP 11500).* Ottawa, ON, Canada, 2002.

Transport Canada. *AC No. 107-001, § 3.6: Guidance on Safety Management Systems Development.* Ottawa, ON, Canada, 2008.

U.S. Department of Agriculture (USDA). Innovative Solutions to Human-Wildlife Conflicts. USDA/APHIS Miscellaneous Publication No. 1608, National Wildlife Research Center, Fort Collins, CO, 2011.

U.S. Geological Survey. Northern Prairie Wildlife Research Center. Available at http://www.npwrc.usgs.gov/ (accessed May 30, 2015).

Vogt, P. F. Control of Nuisance Birds by Fogging with ReJeX-iT® TP-40. In *Proceedings of the Great Plains Wildlife Damage Workshop*, Vol. 13, 1997, pp. 63–66.

Washburn, B. E., B. N. Haslun, M. S. Lowney, and S. M. Tennis. Shooting Gulls to Reduce Strikes at John F. Kennedy International Airport, 1991–2008. *Special Report for the Port Authority of New York and New Jersey, John F. Kennedy International Airport.* USDA, National Wildlife Research Center, Sandusky, Ohio, 2009.

West, B. C., A. L. Cooper, and J. B. Armstrong. Managing Wild Pigs: A Technical Guide. *Human-Wildlife Interactions Monograph*, Vol. 1, 2009, pp. 1–5.

Wright, S. E., and R. A. Dolbeer. Percentage of Wildlife Strikes Reported and Species Identified Under a Voluntary System, in *Proceedings of Bird Strike Committee USA/Canada Meeting.* Vancouver, BC, Canada, 2005.

Xu, Z. Uncertain Multi-Attribute Decision Making. Springer-Verlag, Germany, 2015.

APPENDIX A

Development and Test Airports

Development Airports

Anchorage International Airport
Bangor International Airport
Boise International Airport
Burlington International Airport
Elmira Corning Regional Airport
El Paso International Airport
Fairbanks International Airport
Jacksonville International Airport
Lambert-St. Louis International Airport
Lexington Bluegrass Airport
Pittsburgh International Airport
Southern Illinois University Airport
San Antonio International Airport
Tucson International Airport
The Ohio State University Airport

Test Airports

Dallas-Fort Worth International Airport
Denver International Airport
John F. Kennedy International Airport
McKellar-Sipes Regional Airport
Minneapolis-St. Paul Metropolitan Airport
Orlando International Airport
Portland International Airport
Salt Lake City International Airport
Seattle-Tacoma International Airport

APPENDIX B

Summary of WHM and SMS Survey Findings

1) Survey Participants and National Plan of Integrated Airport System (NPIAS) Categories

Code	NPIAS
DFW	Large
JFK	Large
MSP	Large
MCO	Large
SEA	Large
ANC	Medium
JAX	Medium
PDX	Medium
SAT	Medium
TUS	Medium
ELM	None
MKL	Regional GA
MDH	Regional GA
BOI	Small
FAI	Small

2) Participant Profile Regarding SMS Implementation

Response	a) SMS Program implemented and operational?	b) SMS Program underway?	c) SMS Program planned but not initiated yet?
Yes	6 / 40%	5 / 33%	4/27%
No	7 / 47%	5 / 33%	3 / 20%
other	1 / 7%	4 /27%	7 / 47%

3) Wildlife Management Program in place? Both airports indicating "no" stated they are planning to implement; one in 2014 and the other stated "unknown; however that airport representative stated "We currently have no mandate for a WHMP, but train our employees to the standards set forth by the USDA APHIS WILDLIFE SERVICE."

Does your airport have a Wildlife Hazard Management Plan in place?	Yes	No
	12	2
	80%	13%

4) All airports interviewed indicated they have completed a Wildlife Hazard Assessment.

5) SMS and Wildlife integration is not wide spread.

If you have an SMS in place, have you integrated wildlife data or analysis into your SMS program?	Yes	No	NR / NA
	5	6	4
	33%	40%	27%

6) Wildlife and SMS integration is not wide spread. Comments include: An SMS "risk based" approach utilizing a risk matrix or risk assessment process as defined by the FAA has not been employed, however overall wildlife hazard assessment and mitigation is utilized. Our format is similar to SMS guidance but is not officially recognized as SMS. Table of action items are now in our annual SRA report and are abbreviated only, if needed, in the SEA WHMP.

If you have an SMS in place have you integrated wildlife data or analysis into your SMS program?			
NPIAS	**Yes**	**No**	**Comments**
Large	Y		The wildlife hazard management program is considered under the umbrella of the overall airside aviation-related SMS system
Large	Y		The Safety Risk Assessment process is the method we used to review the WHMP annually to fulfill the FAR 139.337 requirement
If you have a Wildlife Management Program in place, have you integrated SMS into your Wildlife program?			
NPIAS	**Yes**	**No**	**Comments**
Large	Y		An SMS "risk based" approach utilizing a risk matrix or risk assessment process as defined by the FAA has not been employed, however overall wildlife hazard assessment and mitigation is utilized
Large	Y		Our format is similar to SMS guidance but is not officially recognized as SMS
Large	Y		Table of action items are now in our annual Safety Risk Assessment report and are abbreviated only, if needed, in the Airport's WHMP

If you have a Wildlife Management Program in place, have you integrated SMS into your Wildlife program?	Yes	No	NR / NA
	6	8	1
	40%	53%	7%

7) Eighty percent (80%) of the surveyed airports have participated in an FAA led Safety Risk Assessment (SRA) and seventy-three percent (73%) have participated in an internal SRA and seventy-three percent (73%) are familiar with a safety risk matrix.

8) When asked "Who at your airport conducts wildlife risk assessments as part of your SMS program?" Responses included: airport staff and biologist complete annual wildlife hazard plan review not specifically oriented to SMS, Risk Management, some risk analysis is done by the Wildlife Biologists and our contracted USDA staff conduct monitoring and complete annual reports based on the monitoring, ARFF Chief, Ops and USDA WS Biologist, Wildlife Biologist, all my staff provide specific data needed, SMS Manager and Airport Wildlife Biologist, Ongoing Wildlife Hazard Assessment for all staff, and Airport Operations.

Who at your airport conducts wildlife risk assessments as part of your SMS program?	
NPIAS	**Comment**
Large	No formal assessments currently conducted.
None	Airport staff completes annual wildlife hazard plan review not specifically oriented to SMS.
Medium	Risk Management.
Large	Some risk analysis is done by the Wildlife Biologists and our contracted USDA staff conduct monitoring and complete annual reports based on the monitoring.
Regional GA	ARFF Chief.
Large	Survey Respondent (Operations) and USDA Biologist.
Large	Wildlife Biologist.
Medium	Ongoing assessment built into the WHMP. All of my staff provide specific data needed.
Medium	SMS Manager and Airport Wildlife Biologist.
Large	The members of the airport's wildlife hazard working group meet annually to review the airports WHMP annually per 139.337 using the SRA process that results in an annual report (aka Ongoing Wildlife Hazard Assessment).
Regional GA	We currently have no integration of SMS and WHM.
Medium	Responsibility lies with Airport Operations. Additionally, we educate our employee and tenant base in reporting wildlife hazards when they see them.

9) For those airports with no SMS program, the survey asked who would be responsible (in the future). Responses included: USDA-APHIS-WS, Operations with assistance under contract, Wildlife Biologist, Director of Operations, Risk Management, Wildlife Biologists, Management, Operations Director, Wildlife Personnel and Airfield Operations, Airport Staff, and SMS.

10) Eighty-seven percent (87%) of airport respondents have professional wildlife biologists involved in wildlife control and management on their airports.

11) Biologist contract types surveyed included approximately half (47%) full time and half (47%) subcontractor part time as required. Two large hub airports indicated all four types of contracted or employed staff to support their wildlife programs.

a. Airport employee on staff (full time wildlife involvement)	b. Airport employee on staff (part time as required) wildlife involvement	c. Subcontractor (full time wildlife involvement)	d. Subcontractor (part time as required) wildlife involvement
7	2	4	7
47%	13%	27%	47%

12) Eighty-seven percent (87%) of airport respondents have a federal depredation permit for Migratory Bird Treaty Act (MBTA) birds, seventy-three percent (73%) have a state-issued depredation permit for game and non-game wildlife, and seventy-three percent (73%) have a “zero tolerance” policy in place for specific wildlife.

13) Various types of wildlife control and management techniques are used with non-lethal deterrence, live ammunition and non-lethal harassment ranking the highest.

a) Non-lethal harassment (pyrotechnics)	b) Non-lethal deterrence	c) Non-lethal exclosures	d) Lethal toxicants/ fumigants for prey reduction	e) Lethal egg/ nest disturbance	f) Lethal trapping (live trap then euthanize or snap trap, snare)	g) Non-lethal live trapping (live trap then relocate)	h) Live ammunition shooting
14	15	9	4	9	12	9	14
93%	100%	60%	27%	60%	80%	60%	93%

14) Wildlife observations are collected and documented within 5-miles of the airport at seventy-three percent (73%) of the airports surveyed. This data is collected in the following frequency.

a) Daily	b) Weekly	c) Bimonthly	d) Monthly	e) Quarterly	f) Semi-annually	g) Annually
5	4	1	2	1	2	2
33%	27%	7%	13%	7%	13%	13%

15) Wildlife data collection is performed in the following ways indicating that most airports surveyed are collecting data in some means of electronic format including MS Excel or Word. Most software programs reported by airport respondents were managed as part of an airport operations effort (Part 139) not within the SMS software effort. Six of the airports surveyed agreed to provide wildlife data to the research team; however only three were capable of delivering the data in a usable electronic format (Excel and MS Access).

a) Paper only	b) Electronic into some form of database (Excel or MS Word, etc.)	c) Specific software system
4	12	6
27%	80%	40%

16) Airport respondents are storing their wildlife data in the following ways with the national wildlife strike database ranking the highest, hardcopy as the next most frequent, and Excel as the third highest. Some airport respondents indicated that all types of data storage were being used.

a) Software System	b) National Wildlife Strike Database	c) Excel Spreadsheet	d) Word Document	e) Hardcopy / Paper	f) Other
8	13	10	8	11	2
53%	87%	67%	53%	73%	13%

17) Types of data collected include the following with all respondents collecting strike data on airport and very few (2) collecting information from avian radars. All airports indicated they document wildlife control activities conducted by staff and subcontractors and 14 of the 15 airports (93%) reported that tenants/fixed base operators (FBOs) also report wildlife strikes primarily by phone (67%) or through the Internet with FAA Wildlife Strike Database (60%).

a) Strike	b) Wildlife Hazard Assessment	c) Habitat and population assessments	d) Continued Monitoring Surveys	e) Wildlife Sightings	f) Aircraft and/ or vehicle strikes	g) Avian Radar	h) On-Airport	i) Off-airport
15	12	13	12	14	14	2	15	9
100%	80%	87%	80%	93%	93%	13%	100%	60%

18) Eighty percent (80%) of the airports surveyed reported they conduct an annual Wildlife Hazard Review; however only thirty-three percent (33%) use a formal risk assessment process for wildlife management, and only 4 (27%) respondents use a risk matrix as part of the formal risk assessment process. Those using a risk matrix all replied they are using a "5 by 5" model (the 5 by 5 is the model used by the FAA for formal Safety Risk Management).

19) Ninety-three percent (93%) reported that the wildlife data collected thus far has been used for preventive measures.

20) Benefits and challenges reported by airport representatives include the following:

Benefits	Challenges
Getting all active parties to see the importance of reporting wildlife activity and strikes.	Becoming more efficient and effective in focusing efforts and resources.
None reported.	Airport's reporting platforms for wildlife activity and also habitat mitigation activities (fence repairs, mowing, chemical applications), and the FAA Strike database do not interconnect. Access is not user friendly, connections and processes for all except strike database are slow and cumbersome.
The benefit of data collection is that we are able to monitor progress of wildlife removal.	Challenge is keeping employees consistently filling information of sightings on log sheets.
Benefits of collecting data electronically include easy to measure stats such as percentage of non-lethal control, ease of generating reports for permit renewals, annual reports, WHMP reviews, and FOIA requests.	Staff frequently do not use mapping portion of software program; data output is only as good as data input; some airlines do not follow recommended airport protocol for reporting wildlife strikes and late reporting and/or reporting to FAA and not the airport causes loss of data.
None reported.	The primary challenge is deciding exactly what data needs to be tracked and how it will be analyzed to answer the airport's needs. The key is to decide what answers you need, which will drive what questions should be asked which will then determine which data needs to be collected. Many airports are struggling with this because there is not enough guidance available. We all know the standard questions, but to have an effective program, we need to ask deeper questions and look at all of the data available to see if we can build a more preventive system.
Benefit: comparing wildlife observations reports to wildlife strike reports by species to establish priorities.	Challenge: obtaining a system that facilitates field reporting in real time, capable of querying species information by location and time.
The benefit is good data that supports the need for change or modification and the justification to end, continue, or implement new proactive management approaches.	The turnover in airline staff and airport users poses an ongoing challenge.
None reported.	Determining a precise annual strike rate (strikes/10,000 operations) is difficult when reporting is inconsistent.
None reported.	Incorporating the tower to proactively request mitigation techniques be utilized during reported problems, most of the time they take the reports from pilots and we provide mitigation from overhearing the conversations on the radio. Getting pilots to report wildlife strikes to the FAA database, as we cannot provide most of the information regarding the incident after the fact. The reports would help to determine locations where repeated problems may be occurring and allow us a chance to visually inspect the areas close to reported incidents.
Benefits: Enhancement of safety by having a formalized approach to wildlife management. Trending analysis improvements. Managing wildlife on the airport in the most humane way as reasonably as possible.	The challenge is collecting the right data for the purpose we are trying to serve -- improve safety. Writing the plan and implementing it. Communication is always an issue. Getting buy-in from the tenants.

APPENDIX C

The WHaMRAT User Guide

Note: Photographs, figures, and tables in this Appendix have been converted from color to grayscale for printing. The electronic version (posted on the web at www.trb.org) and the User Guide included on CRP-CD 173 both retain the color versions.

Appendix C: Contents

1.0 The EZ-Version WHaMRAT

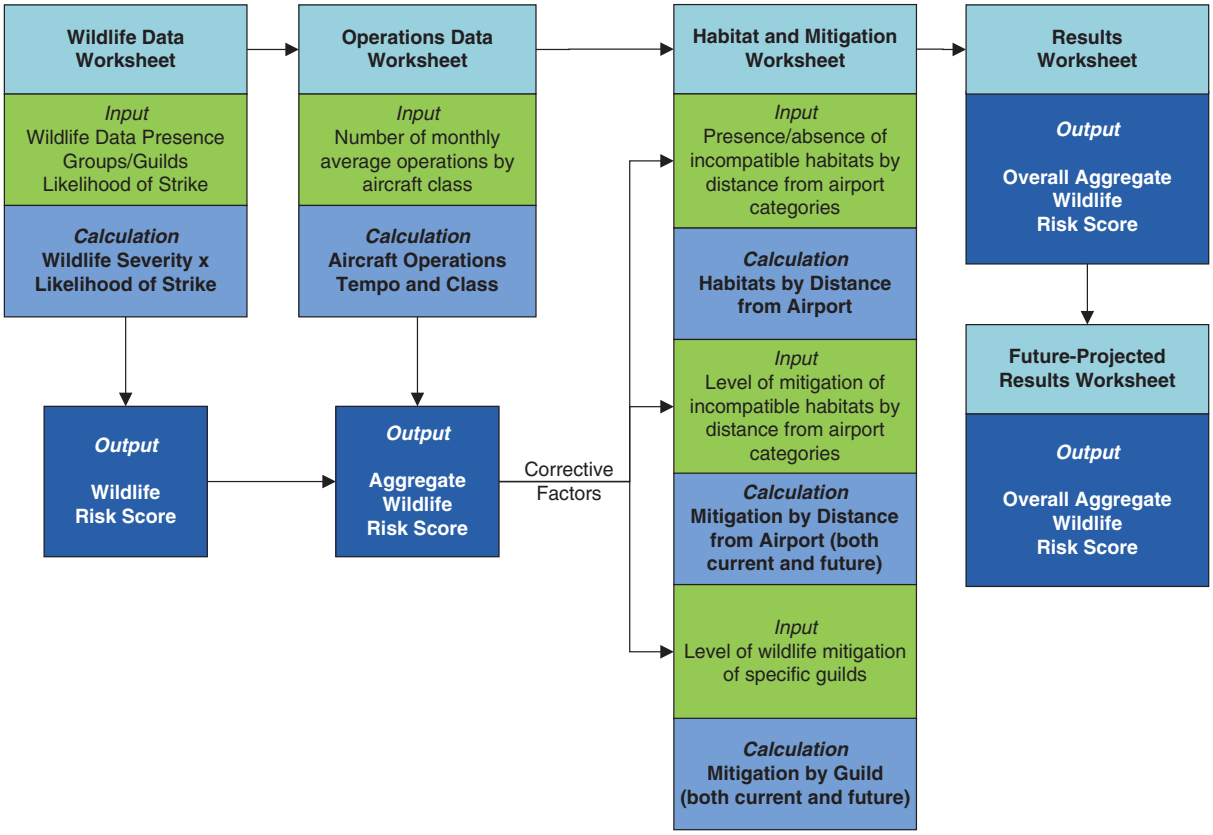
The Wildlife Hazard Management Risk Assessment Tool (WHaMRAT) is designed to assist wildlife and airport managers in assessing the wildlife risk to aircraft operations. The WHaMRAT contains three user-input worksheets and two results worksheets in a spreadsheet (Microsoft Excel) format incorporates various formulas and calculations working together to determine an Overall Aggregate Wildlife Risk Score. The tool requires user inputs that account for measures of wildlife presence and abundance, monthly average aircraft movements by aircraft type, classes and locations of habitat considered incompatible with safe aircraft operations, and current and future wildlife mitigation actions. These data entries produce a numerical result and graphical representation of current wildlife risk depicted as low, moderate, or high using a 1-to-5 scale (1 is low and 5 is high). The user also can enter optional future wildlife mitigation efforts and can view the potential impacts in the Future-Projected Results Worksheet.

The WHaMRAT is built on a Multi-Attribute Decision Making (MADM) framework, taking wildlife presence and the potential likelihood of wildlife strikes to determine an Aggregate Wildlife Risk Score for the airport (Belton 1986, Xu 2015). User inputs for aircraft class and monthly airport operations tempo contribute to an Overall Aggregate Wildlife Risk Score for the airport, as do adjustment factors built into the WHaMRAT that reflect the presence of habitats incompatible with aircraft operations and the effects of current and future habitat and wildlife management and control mitigation efforts (Figure 1). The adjusted information is then presented visually through two risk matrices that show (1) an EZ-Version Wildlife Severity versus Likelihood of Strike Matrix (Figure 2); and (2) an EZ-Version Wildlife Risk vs. Operations Adjustment Risk Matrix (Figure 3).

The research team developed two versions of the WHaMRAT—the EZ-Version WHaMRAT and the Advanced-Version WHaMRAT. The EZ-Version WHaMRAT allows universal application to all airport or wildlife staff, regardless of airport size and airport operation experience. It is best practice for all airport or wildlife staff to use the EZ-Version WHaMRAT initially. The primary difference between the two versions is the ability to further discriminate wildlife species within guilds, species presence, and associated targeted wildlife mitigation efforts in the Advanced-Version WHaMRAT.

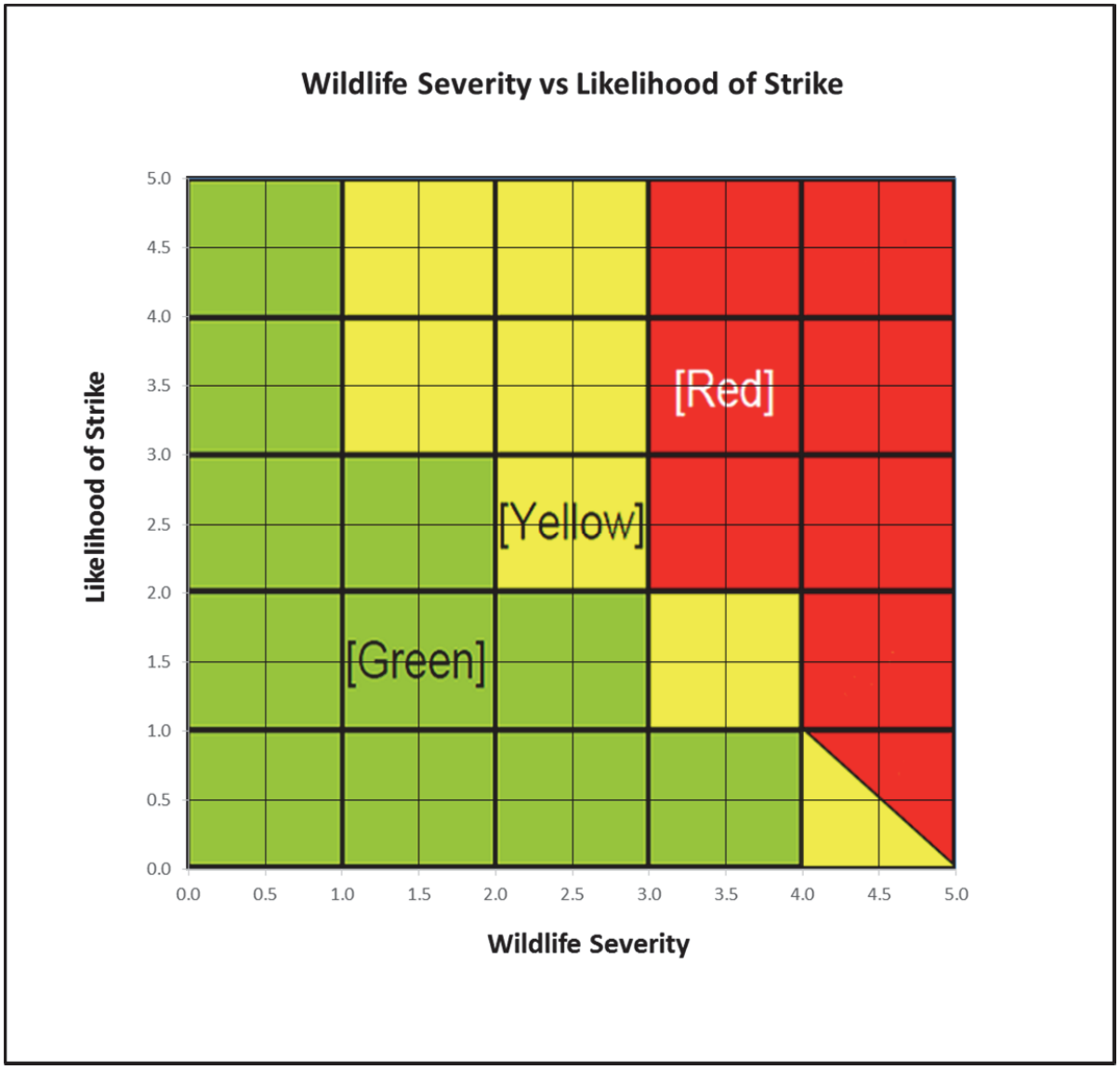
Two-page Quick-Start Guides are provided for each version of the WHaMRAT in Attachments 11 and 12. The information in the balance of this section provides a general overview of airport operator input into the EZ-Version WHaMRAT.

Figure 1: WHaMRAT Detailed Model Overview



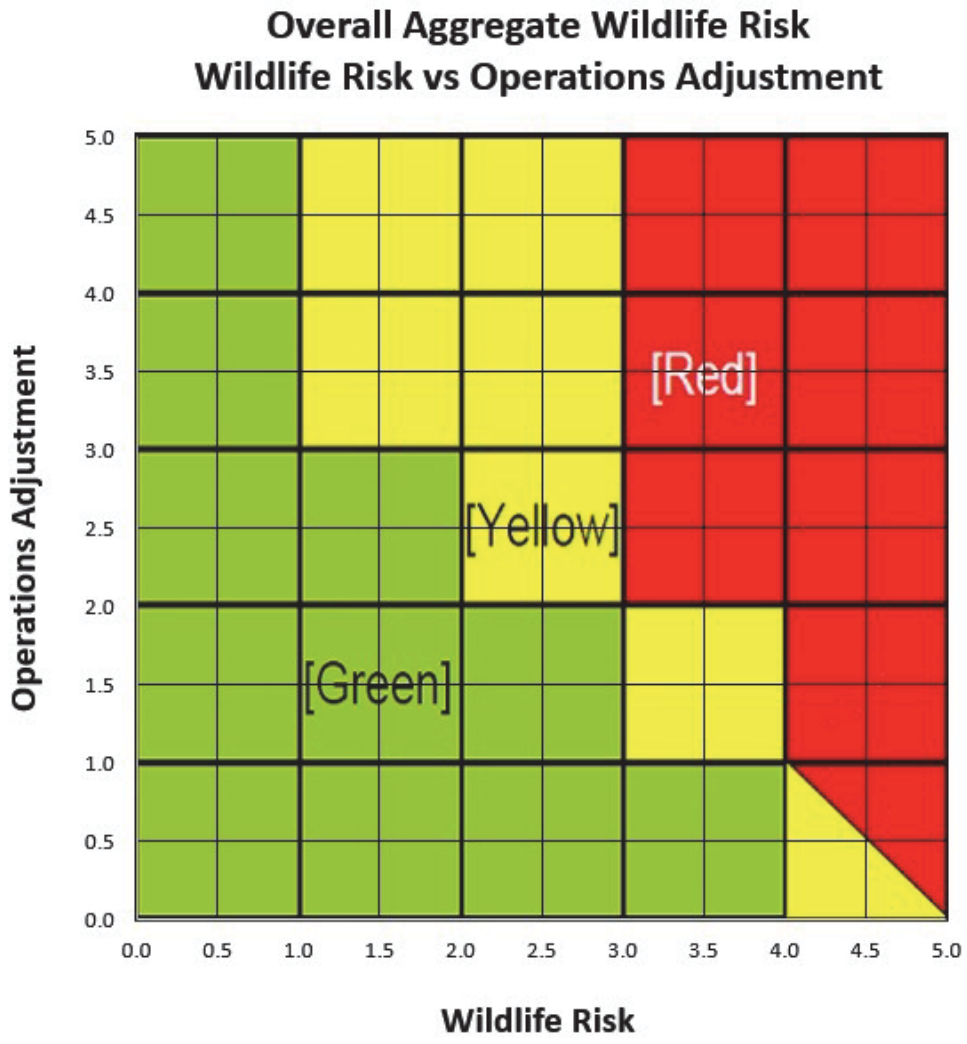
Source: BASH Inc.

Figure 2: EZ-Version Wildlife Severity vs. Likelihood of Strike Matrix



Source: WHaMRAT (BASH Inc.)

Figure 3: EZ-Version Wildlife Risk vs. Operations Adjustment Matrix



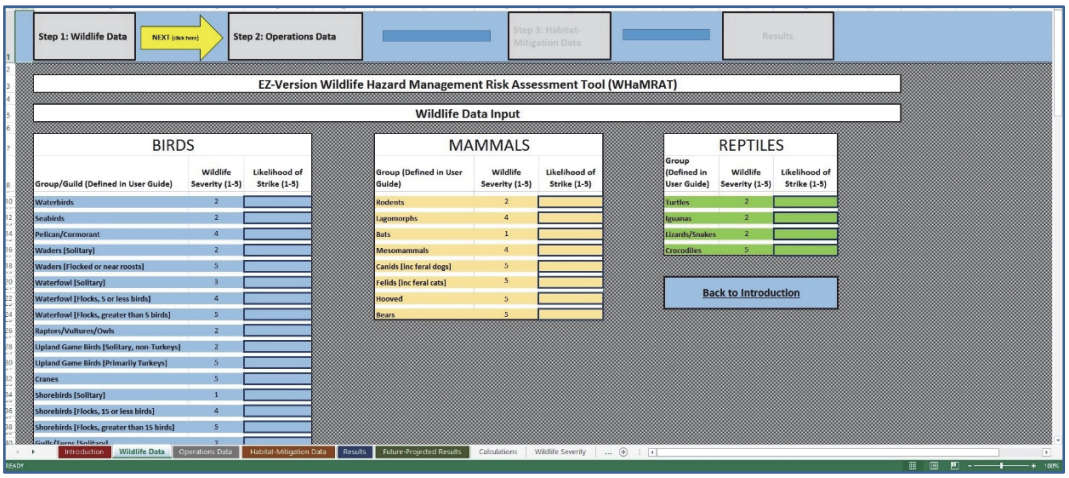
Source: WHaMRAT (BASH Inc.)

EZ-Version Wildlife Data Worksheet
Wildlife Data User Input

1.1 The EZ-Version WHaMRAT Wildlife Data Worksheet—Overview

The Wildlife Data Worksheet is the foundation of the entire WHaMRAT (Figure 4). Within this worksheet, the user will identify those avian, mammalian, and reptilian guilds present on and surrounding the airport property and enter a Likelihood of Strike Score for each of these guilds. The worksheet is illustrated in Figure 4.

Figure 4: The EZ-Version WHaMRAT Wildlife Data Worksheet



Assumptions:

- *Severity x Likelihood of Strike for 1 Guild = Wildlife Risk.* The cumulative Wildlife Risk scores of all guilds is the Aggregate Wildlife Risk.
- Measurements of wildlife severity are based solely on the average body mass of each species within a specific guild. A guild will contain varied species (detailed in Guild Designations, Attachment 1). If identification of wildlife is reported at the species level, then the species must be placed in the appropriate guild by referencing Attachments 6 and 7.

Wildlife Data Worksheet Explanation—Severity

Within the WHaMRAT, wildlife severity is an objective score ranging from 1 to 5 (whole numbers only) based solely on body mass (in grams) at the guild level for user-identified guilds present in the airport environment. Guilds are defined as groups of species that exhibit common behavior, habitat use, and natural histories, but are not necessarily taxonomically related. There is no current consensus for guild designations in the avian, mammalian, or reptilian literature, and species were placed in the designations for the purposes of this application based on behavioral associations most often observed on or near airports. The guild designations and associated wildlife types within the EZ-Version WHaMRAT are detailed in Attachments 2, 3, 6, and 7. In the EZ-Version WHaMRAT, any species contained within a specific guild will have an identical

Severity Score that represents the average body mass of all species contained within that guild (Attachments 2 and 3). Additional potential variations in the general guild Severity Score result when (1) species within a guild demonstrate flocking behavior or (2) certain species within a guild are significantly larger in mass than most individual species within a guild. To account for flocking, the WHaMRAT allows for variation in the guild Severity Score for Waders, Waterfowl, Shorebirds, Gulls/Terns, Doves/Pigeons, Corvids, and Blackbirds/Starlings guilds based on different flock sizes, with severity increasing as flock sizes increase. To account for the larger mass of Wild Turkeys, in the Upland Game Birds guild an increase in guild Severity Score occurs only if Wild Turkeys are present. Severity is set in the WHaMRAT and not modifiable by the user. Avian Wildlife Severity Scores that include flocking adjustment to Severity Scores at the guild level are detailed in Table 1:

Table 1: EZ-Version WHaMRAT Avian Guilds and Severity Score
Weights expressed in grams (g)

Guilds	Severity
Waterbirds	**2**
Seabirds	**2**
Pelicans/Cormorants	**4**
Waders	**2**
If flocks ≥ 5	**5**
Waterfowl	**3**
If flocks < 5	**4**
If flocks ≥ 5	**5**
Raptors/Vultures/Owls	**2**
Upland Game Birds	**2**
If Turkeys	**5**
Cranes	**5**
Shorebirds	**1**
If flocks < 15	**4**
If flocks ≥ 15	**5**
Gulls/Terns	**2**
If flocks < 10	**4**
If flocks ≥ 10	**5**
Pigeons/Doves	**1**
If flocks < 20	**4**
If flocks ≥ 20	**5**
Parrots	**1**
Aerial Foragers	**1**
Woodland Birds	**1**
Corvids	**2**
If flocks < 10	**4**

(*continued on next page*)

Guilds	Severity
If flocks ≥ 10	5
Grassland Birds	1
Blackbirds/Starlings	1
If flocks < 100	4
If flocks ≥ 100	5
Miscellaneous	1
Criteria for Score	**Severity**
Less than 300g	1
300-999g	2
1000-1999g	3
2000-3999g	4
Greater than 4000g	5

Source: BASH Inc.

When determining severity for mammals and reptiles, the process is identical to the avian description detailed above. However, threshold levels for severity by body mass differ for terrestrial mammals when compared with birds. Mammalian and reptilian Wildlife Severity Scores at the guild level are detailed in Table 2:

Table 2: EZ-Version WHaMRAT Mammalian and Reptilian Guilds and Severity Score
Weights expressed in grams (g)

Guilds	Severity
Rodents	2
Lagomorphs	4
Bats	1
Mesomammals	4
Canids	5
Felids	5
Hooved	5
Bears	5
Turtles	2
Iguanas	2
Lizards/Snakes	2
Crocodiles/Alligators	5

(*continued on next page*)

Criteria for Score	Severity
0-99g	**1**
100-599g	**2**
600-1999g	**3**
2000-9999g	**4**
Greater than 10000g	**5**

Source: BASH Inc.

Wildlife Data Worksheet Explanation—Likelihood of Strike

Assumptions:

- S*everity x Likelihood of Strike for 1 Guild = Wildlife Risk.* The cumulative Wildlife Risk scores of all guilds make up the Aggregate Wildlife Risk.
- Wildlife Likelihood of Strike is based solely on estimates of abundance determined by objective wildlife observations contained within Wildlife Hazard Assessments (WHAs), Wildlife Hazard Site Visits (WHSVs), or reference documents.

Likelihood of wildlife strike is a user-determined score based solely on an objective estimate of abundance of a particular wildlife species relative to airport operating surfaces. No consideration for the size of the wildlife present should be given when determining likelihood, as body mass is already accounted for in the severity index. Airport or wildlife staff can determine the likelihood value for each guild previously identified in the severity tables based on estimated abundance data by species and/or guild reported within a WHA or WHSV, or obtained from other local data sources. If such data do not exist, then the severity and likelihood value should be determined using abundance data from wildlife identification field guides or handbooks or via Internet sources such as the USGS Northern Prairie Wildlife Research Center (accessed at http://www.npwrc.usgs.gov/). Most wildlife identification handbooks include information on range and seasonal presence of species, including observation rankings from “rare” to “abundant.” The USGS Northern Prairie Wildlife Research Center also provides species lists and observation rankings for numerous wildlife refuges, wildlife areas, and so forth, that may be in close proximity to a given airport. Airport operators could extrapolate such data sources to make an educated estimate of species/guild presence and estimated abundance for their particular location and by season. The following Likelihood Scores are recommended when using referenced sources that provide abundance information:

- Species not present at all: Likelihood Score = 0 (or cell left blank).
- Rare: Likelihood Score = 1.
- Uncommon: Likelihood Score = 2.
- Fairly Common: Likelihood Score = 3.
- Common: Likelihood Score = 4.
- Abundant: Likelihood Score = 5.

It cannot be overstated that the effectiveness of the WHaMRAT is predicated by appropriate assignments of Wildlife Severity and Likelihood of Strike scores. The cumulative effect of the aggregate Wildlife Severity of guilds present and the associated Likelihood of Strike scores for each guild present determines an initial (current-state) Aggregate Wildlife Risk Score (ranging from 1 to 5) for a particular airport.

1.2 The EZ-Version WHaMRAT Wildlife Data Worksheet—User Data Entry

Within this worksheet, users will:

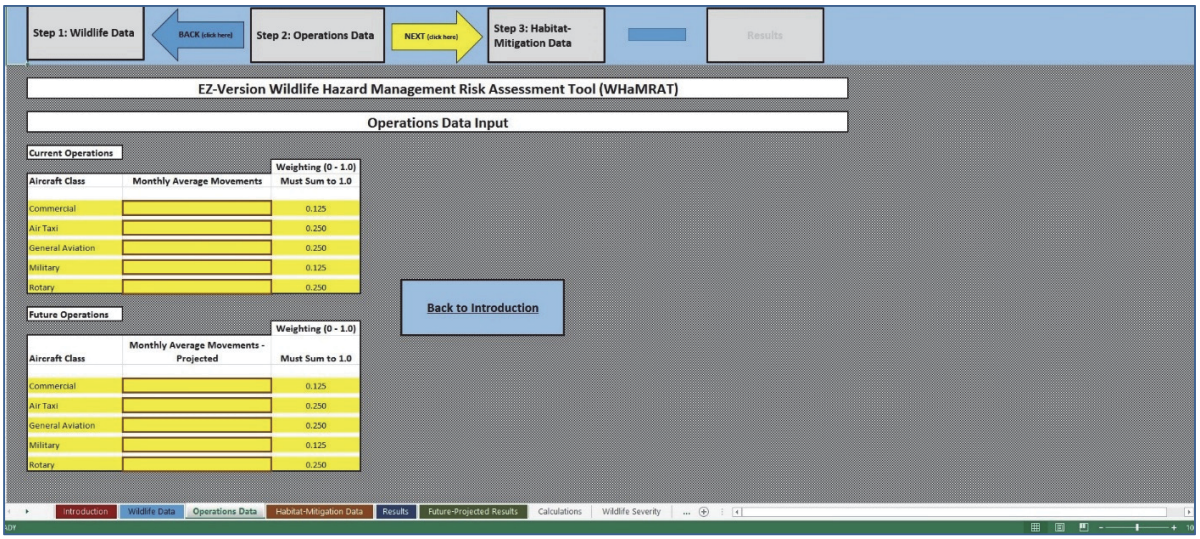
- Determine the presence of wildlife guilds using wildlife observation data provided by a WHA, WHSV, or pertinent literature. To identify appropriate guilds, reference the Guild Designation categories contained in Attachments 2 and 3. If information is available at the species level, then species-level information by guild is contained in Attachments 6 and 7.
- For each guild identified in the user determination of species presence, input a Likelihood of Strike Score ranging from 1 to 5 (whole numbers only) using solely estimates of abundance. If a guild is not identified, then leave the Likelihood of Strike Score blank for that specific guild.

EZ-Version Operations Data Worksheet
Operations Data User Input

1.3 The EZ-Version WHaMRAT Operations Data Worksheet—Overview

The Operations Data Worksheet is a critical component in determining the Overall Aggregate Wildlife Risk Score that is based on the Aggregate Wildlife Risk Score (determined in the Wildlife Data Worksheet) as well as the number of monthly aircraft operations and susceptibility to damage by aircraft class, referred to as the Operations Adjustment. The worksheet is illustrated in Figure 5.

Figure 5: The EZ-Version WHaMRAT Operations Data Worksheet



Assumptions:

- An adjustment factor to the initial Aggregate Wildlife Risk Score is applied based on the number of average monthly aircraft movements as compared to the average monthly aircraft movements in airports across the United States[1]. This adjustment becomes a component of the Overall Aggregate Wildlife Risk Score.
- The operations adjustment factor applied to the Aggregate Wildlife Risk Score accounts for monthly aircraft operations and aircraft class susceptibility to damage.

Operations Data Worksheet Explanation—Aircraft Operations and Aircraft Class

The Operations Data Worksheet calculates the risk associated with airport operations given the amount of monthly aircraft operations and the class of aircraft operating at an airport. In FAA's Air

[1] Average number of aircraft operations at airports across the United States is taken from the FAA Air Traffic Activity Data System (ATADS) containing the official NAS air traffic operations data.

Traffic Activity Data System (ATADS), airports report four classes of aircraft and their total number of movements to FAA: Commercial, Air Taxi, General Aviation, and Military. In the WHaMRAT, another class—Rotary Wing—is included, resulting in five classes requiring user inputs in this worksheet. The EZ-Version WHaMRAT accepts input of the number of monthly aircraft movements broken down as follows:

- **Commercial –** An aircraft with a seating capacity of more than 60 seats or a maximum payload capacity of more than 18,000 pounds carrying passengers or cargo for hire or compensation (itinerant and local).
- **Air Taxi** – An aircraft originally designed to have no more than 60 passenger seats or a cargo payload of 18,000 pounds and carries cargo or mail on either a scheduled or charter basis, and/or carries passengers on an on-demand basis or limited-schedule basis (i.e., on four or fewer round trips a week on at least one route according to published flight schedules) only.
- **General Aviation –** All civil aircraft, except those classified as air carriers/commercial or air taxis.
- **Military –** All military aircraft, turboprop and jet (itinerant and local).
- **Rotary –** An aircraft that uses lift generated by wings/rotors that rotate around a vertical axis or mast.

Each aircraft class is weighed differently in the calculation based on the aircraft class susceptibility to damage. Within the WHaMRAT, an adjustment factor by susceptibility of damage[2] by aircraft class is automatically applied to each class of aircraft. The susceptibility weighting factor was determined by examining the FAA Wildlife Strike Database to determine damage levels recorded by various aircraft categories when exposed to strikes with similar wildlife species.

In addition to user input into the current monthly airport operations by aircraft class, an additional user input into future monthly airport operations is available to determine the effect of planned increases or decreases in monthly air operations. Having input predicted future monthly airport operations, the user can project the effects of changes in monthly airport operations relative to the Aggregate Wildlife Risk Score.

1.4 The EZ-Version WHaMRAT Operations Data Worksheet—User Data Entry

Within this worksheet, users will:

- Determine the number of monthly airport operations by aircraft class.
- For each aircraft class, input the number of current monthly airport operations by aircraft class. If changes are expected in the number of monthly operations by aircraft class, input this information into the future table of the worksheet. If no changes are expected, input the same numbers in both the future operations and current operations tables.

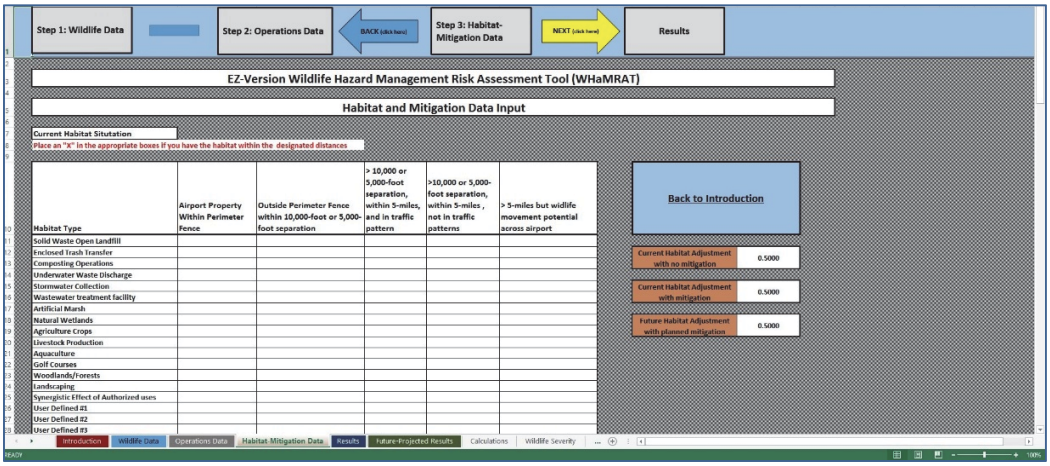
[2] Susceptibility to damage is calculated by using the ratio of damaging strikes against total strikes for each class of aircraft as reported in the FAA National Wildlife Strike Database.

EZ-Version Habitat and Mitigation Worksheet
Habitat and Mitigation User Input

1.5 The EZ-Version WHaMRAT Habitat and Mitigation Worksheet—Overview

The Habitat and Mitigation Worksheet initially accounts for the presence or absence of habitats deemed incompatible with aircraft operations by FAA. These habitats, as well as the habitat distance from the airport property, influence the Aggregate Wildlife Risk Score by applying a Habitat Adjustment factor. The level of habitat mitigation, both current and future, also is included in this worksheet to account for the influence of habitat mitigation on wildlife risk via a Habitat Mitigation Adjustment factor. Lastly, wildlife mitigation by specific guild, both current and future, also is included within this worksheet to account for wildlife mitigation on the Aggregate Wildlife Risk Score, via a Wildlife Mitigation Adjustment factor. The worksheet is illustrated in Figure 6.

Figure 6: The EZ-Version WHaMRAT Habitat and Mitigation Worksheet



Assumptions:

- A Habitat Adjustment factor is applied to the Aggregate Wildlife Risk Score based on the cumulative presence or absence of habitats that are incompatible with aircraft operations. This adjustment, combined with the Operations Adjustment, results in the Overall Aggregate Wildlife Risk Score.
- The effect on wildlife risk decreases as the distance from the airport property increases.
- Mitigation efforts are effective and reduce the impact of incompatible habitat.

Habitat and Mitigation Worksheet Explanation—Habitat Presence or Absence

The Habitat and Mitigation Worksheet is designed to identify those habitats that are considered incompatible with airport operations, and the WHaMRAT accounts for those habitats identified in FAA AC 150/5200-33B. The user identifies the current presence or absence of such habitats by placing an "*x*" in the appropriate habitat row specific to a column indicating its location relative to the airport property. In addition to the habitats listed, the worksheet allows users to add up to

three additional, “user-defined” habitats unique to their situation that may attract wildlife and therefore should be taken into account. These additional habitats are identified as “User-defined.”

Specific incompatible habitats in the WHaMRAT include:

- Solid waste open landfill.
- Enclosed trash transfer.
- Composting operations.
- Underwater waste discharge.
- Stormwater collection.
- Wastewater treatment facility.
- Artificial marsh.
- Natural wetlands.
- Agricultural crops.
- Livestock production.
- Aquaculture.
- Golf courses.
- Woodlands/forests.
- Landscaping.
- Synergistic effects of authorized uses.
- User-defined #1.
- User-defined #2.
- User-defined #3.

The user input also allows for the identification of habitat presence and/or absence at varying distances from the airport property. These distances account for (1) FAA separation criteria of 5,000 feet (airports serving piston-driven aircraft), 10,000 feet (airports serving turbofan-driven aircraft), and 5 miles, as identified in FAA AC 150/5200-33B. Each habitat distance location from the airport is weighted differently in a decreasing decay function as the habitat is located farther from the airport property. Thus, incompatible habitats at greater distances from the airport property have less effect on the adjustment factor applied to the Aggregate Wildlife Risk Score.

Specific distance categories included in the WHaMRAT are:

- On airport property, within the perimeter fence.
- Outside the perimeter fence but within 10,000-foot or 5,000-foot separation distances.
- At distances greater than 10,000-foot or 5,000-foot separation but within 5 miles, and in the traffic pattern.
- At distances greater than 10,000-foot or 5,000-foot separation but within 5 miles, and not in the traffic pattern.

- Greater than 5 miles but there is wildlife movement potential across airport.

1.6 The EZ-Version WHaMRAT Habitat and Mitigation Worksheet—User Data Entry for Habitat Presence or Absence

Within this worksheet, users will:

- Incorporate information from the airport master plan, land use maps, and habitat information for the surrounding area up to 5 miles from the airport property to determine the presence of habitats that are considered incompatible with aircraft operations.
- Input the presence of incompatible habitats by placing an "*x*" in the appropriate column that indicates the distance from the airport property. If an incompatible habitat is not present, the user can leave this column cell blank.

Habitat and Mitigation Worksheet Explanation—Current Habitat Mitigation

Assumptions:

- An adjustment factor to the Aggregate Wildlife Risk Score is applied in the WHaMRAT based on the cumulative level of current habitat mitigation practices specific to habitats that are incompatible with aircraft operations. This adjustment, combined with the Operations Adjustment, results in the Overall Aggregate Wildlife Risk Score.
- The habitat's effect on wildlife risk decreases as a decay function when the distance from the airport property increases.
- Increases in habitat mitigation will decrease wildlife risk, whereas decreases in habitat mitigation will increase wildlife risk.

Note: If a habitat has been completely mitigated, such as a natural wetland that has been completely filled in, then that habitat no longer exists and an "*x*" should NOT be placed in that habitat row/column.

Once the user has identified all incompatible habitats, inputs are added about the habitat mitigation efforts associated with these habitats. If an airport is performing some form of mitigation associated with a specific habitat, the user inputs low (1), moderate (2), or high (3) for the level of habitat mitigation currently in place. These data inputs should include all habitats identified for all locations relative to the airport if mitigation is currently taking place. Habitat mitigation outside of airport properties often is difficult and non-jurisdictional. Thus, the inputs for current habitat mitigation at increasing distances from the airport may be none ("0") or left blank in the user input.

1.7 The EZ-Version WHaMRAT Habitat and Mitigation Worksheet—User Data Entry for Current Habitat Mitigation

Within this worksheet, users will:

- Determine the level of habitat mitigation currently in place for habitats identified by location. Input values will range from 1 (low), to 2 (moderate), to 3 (high) (whole numbers only).

- Input the level of current habitat mitigation for each incompatible habitat by placing either a 1 (low), 2 (moderate), or 3 (high) in the appropriate cell (habitat row and distance-from-airport column). If no habitat mitigation is currently ongoing, leave the appropriate cell blank. In addition, if an incompatible habitat is not/no longer present, leave the column and row cell blank.

Habitat and Mitigation Worksheet Explanation—Future Habitat Mitigation

Assumptions:

- An adjustment factor to the Aggregate Wildlife Risk Score is applied in the WHaMRAT based on the cumulative level of input (future planned) habitat mitigation practices specific to habitats that are incompatible with aircraft operations. This adjustment, combined with the Operations Adjustment, results in the future-projected Overall Aggregate Wildlife Risk Score.
- The effect of habitat mitigation on wildlife risk decreases as a decay function when the distance from the airport property increases.
- Increases in habitat mitigation will decrease wildlife risk, whereas decreases in habitat mitigation will increase wildlife risk.

The WHaMRAT offers users the option to input and evaluate future habitat mitigation efforts. The data input process is identical to that used for current habitat mitigation. However, users can account for increased or decreased habitat mitigation efforts associated with a particular habitat (row) and location from the airport (column) and evaluate their effects by using this feature. If no future habitat mitigation is planned, leave the rows and columns blank.

1.8 The EZ-Version WHaMRAT Habitat and Mitigation Worksheet—User Data Entry for Future Habitat Mitigation

Within this worksheet, users will:

- Determine the potential change in the level of future habitat mitigation for habitats identified by location. Input values will range from 1 (low), to 2 (moderate), to 3 (high) (whole numbers only).
- Input the level of future habitat mitigation for each incompatible habitat by placing a 1 (low), 2 (moderate), or 3 (high) in the appropriate cell (habitat row and distance-from-airport column). If no habitat mitigation change is planned, input the same number as was input for the current habitat mitigation. If a habitat mitigation change is planned, then put the appropriate value (ranging from 1 to 3) into the cell for that habitat. If an incompatible habitat is not (or no longer) present, leave the cell blank for that habitat.

In summary, the user input into habitats and associated habitat mitigation efforts allows users to evaluate both current and future habitat mitigation efforts and their effect on wildlife risk, based on habitat attraction and relative distance from the airport.

Habitat and Mitigation Worksheet Explanation—Current and Future Wildlife Mitigation by Guild

Assumptions:

- An adjustment factor to the Aggregate Wildlife Risk Score is applied based on the cumulative level of current and future wildlife mitigation practices specific to wildlife guilds that are present and identified in the Wildlife Data Worksheet. This adjustment, combined with the Operations Adjustment, results in the Overall Aggregate Wildlife Risk Score.
- One specific technique or method of wildlife mitigation may affect more than one guild. A combination of wildlife mitigation techniques or methods results in higher levels of wildlife mitigation for a specific guild.
- Increases in wildlife mitigation will decrease wildlife risk, whereas decreases in wildlife mitigation will increase wildlife risk.
- Current wildlife abundance is measured with current guild mitigation efforts in place. Therefore, current mitigations of certain guilds will not change the current wildlife score. However, input of current mitigation levels against those guilds is required to correctly assess the impact of future mitigation efforts.
- Future mitigation efforts should be at least at the same levels as current mitigation efforts. Failure to maintain current mitigation levels and failure to input the level of mitigation into the future guild mitigation column will increase the Overall Aggregate Wildlife Risk Score.

Users can input wildlife mitigation efforts targeted at specific wildlife guilds. As with the habitat mitigation input, users can input both current and future wildlife mitigation effort levels ranging from 1 (low), to 2 (moderate), to 3 (high), specific to a targeted guild. Airport staff or wildlife staff have numerous wildlife management and control options available. Many of these options are specific to a target species or guild; however, many other options are less specific to a particular species or guild and may affect several guilds simultaneously. One example of such a mitigation is maintaining turf at recommended heights of 6-12 inches. The managed turf height is an effective wildlife mitigation on many guilds. Turf management, combined with additional measures—such as non-lethal harassment and deterrence, as well as lethal measures—can have a synergistic effect on wildlife control mitigation and substantiate user-input values of 2 (moderate) and/or 3 (high) when all wildlife control and mitigation measures are taken into account. By allowing users to input levels for both current and future (planned) wildlife mitigation efforts by guild, the WHaMRAT allows users to evaluate potential future wildlife mitigation efforts and prioritize wildlife mitigation targeted at problem species/guilds.

1.9 The EZ-Version WHaMRAT Habitat and Mitigation Worksheet—User Data Entry for Current Wildlife Mitigation by Guild

Within this worksheet, users will:

- Determine the level(s) of wildlife mitigation currently in place for specific guilds present in the airport environment identified previously in the Wildlife Data Worksheet. Input values will range from 1 (low), to 2 (moderate), to 3 (high) (whole numbers only).
- Input the level of current wildlife mitigation for each guild by placing a number (1, 2, or 3) in the appropriate guild row under the current wildlife mitigation column. If no wildlife mitigation for a specific guild is currently ongoing, leave the appropriate cell blank.

1.10 EZ-Version Habitat and Mitigation Worksheet User Data Entry for Future Wildlife Mitigation by Guild

Within this worksheet, users will:

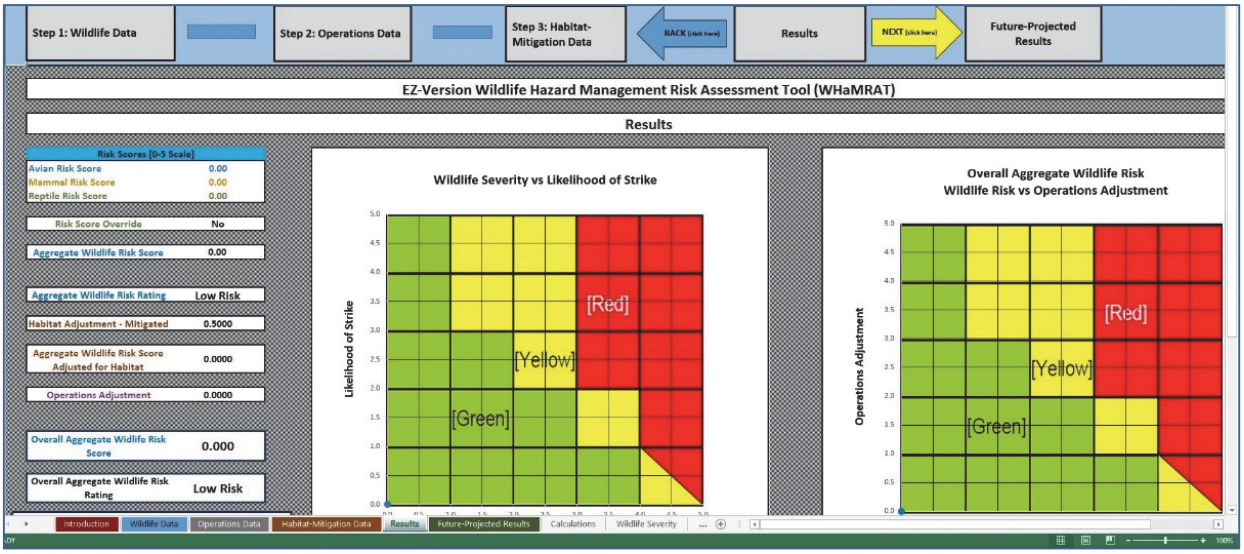
1) Determine potential changes in the level(s) of future wildlife mitigation for specific guilds present in the airport environment identified previously in the Wildlife Data Worksheet. Input values will range from 1 (low), to 2 (moderate), to 3 (high) (whole numbers only).
2) Input the level of future planned wildlife mitigation for each guild by placing a number (1, 2, or 3) in the appropriate guild row under the future wildlife mitigation column. If the level of planned wildlife mitigation remains the same as the current level, a value should be input that is identical to the value that was placed in the current wildlife mitigation column. If the level of planned wildlife mitigation is different than the current condition (increased or decreased), then place the appropriate value in the future mitigation column. If no future wildlife mitigation for a specific guild is planned, leave the appropriate cell blank.

EZ-Version Results Worksheet
Results

1.11 The EZ-Version WHaMRAT Results Worksheet

The Results Worksheet provides the final overview of the current state of affairs relative to wildlife risk at the airport based on the user input to all previous worksheets relative to the current condition (Figure 7). It provides both graphical and numeric summaries of wildlife risk, and reflects the effects of operations tempo and aircraft class, as well as habitat and wildlife mitigations, on wildlife risk.

Figure 7: The EZ-Version WHaMRAT Results Worksheet



The left part of the Results Worksheet gives the numerical results (Figure 7). On the right are the graphical summaries. The first numerical result is a breakdown of the Wildlife Risk Score by wildlife type—Avian, Mammal, and Reptile—on a scale of 0 to 5 (Figure 8).

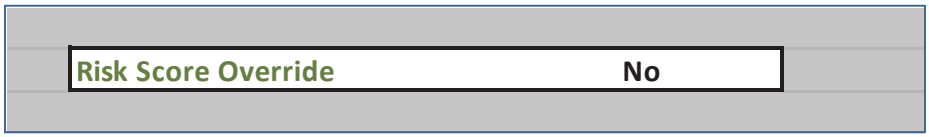
Figure 8: Wildlife Risk Scores

Risk Scores [0-5 Scale]	
Avian Risk Score	1.28
Mammal Risk Score	0.73
Reptile Risk Score	0.11

These three wildlife scores form the foundation of the Aggregate Wildlife Risk Score. The higher the score for each wildlife type, the higher the risk. Figure 8 includes sample scores that show the highest risk coming from avian wildlife.

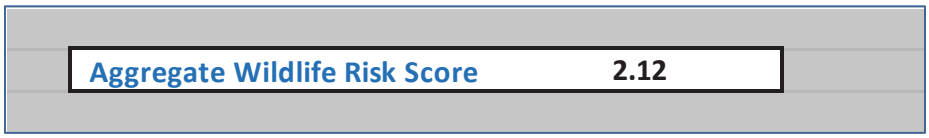
Under the individual wildlife scores (see Figure 7) is a Yes/No indication of any override in the calculation of the Aggregate Wildlife Risk Score (Figure 9). A Risk Score Override occurs when the user inputs high Likelihood of Strike Scores for a guild/species with a high severity. Many of these wildlife are "zero-tolerance" wildlife species, and when such species are abundant, this situation will force the overall score to fall into the high risk category. These guilds/species that result in an override are those that become highlighted red on the Wildlife Data Worksheet when high Likelihood of Strike Scores are entered. Overrides also can occur with a combination of a number of mid-level Likelihood of Strike ratings for high severity wildlife, which will be highlighted in yellow text. A Risk Score Override will force the Aggregate Wildlife Risk Score to be a minimum value based on the type of override.

Figure 9: Risk Score Override



The Aggregate Wildlife Risk Score is the sum of the individual wildlife risk scores (Figure 10). This score is assessed and given a rating of Low Risk, Moderate Risk, or High Risk based on the first graph to the right of the numerical scores column (see Figure 7).

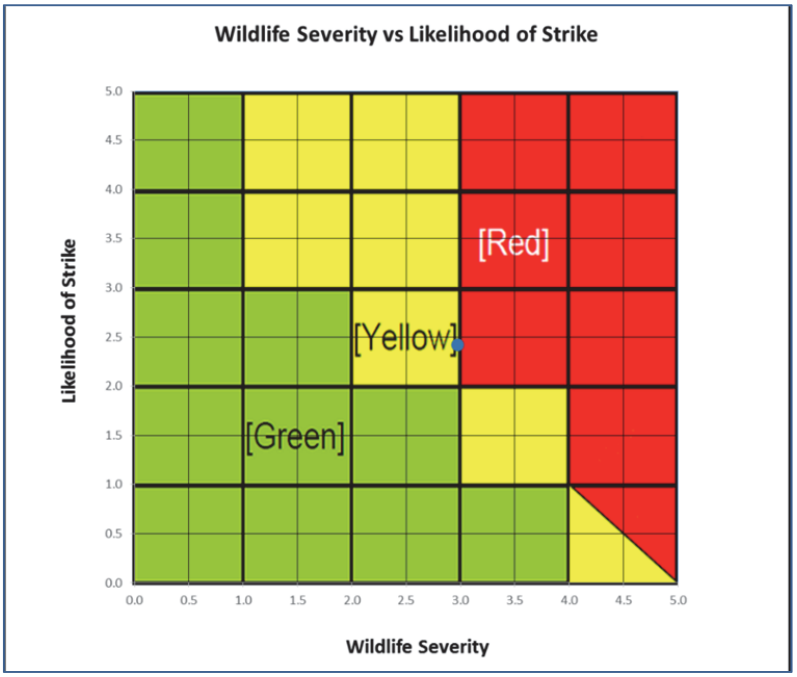
Figure 10: Aggregate Wildlife Risk Score



The graph accounts for the two Aggregate Wildlife Risk components (Likelihood of Strike and Wildlife Severity) and plots them against each other. The sample plot shown in Figure 11 (blue dot) lands in the yellow area of the graph, which denotes Moderate Risk. The associated risk shown graphically in Figure 11 also is noted as the Aggregate Wildlife Risk Rating (Figure 12), which appears on the left side of the Results Worksheet.

The example depicted in Figure 11 and Figure 12 shows the current state as "Moderate Risk." To move from the current state to a lower risk condition would require either removing some of the higher severity wildlife species (which causes the Wildlife Severity component to be reduced) or decreasing wildlife abundance on the airport (resulting in less Likelihood of Strike) or a combination of both.

Figure 11: Wildlife Severity vs. Likelihood of Strike Risk Matrix



Source: WHaMRAT (BASH Inc.)

Figure 12: Aggregate Wildlife Risk Rating

The next numerical result displayed is the Habitat Adjustment – Mitigated (Figure 13). This number reflects the increase or decrease in risk resulting from the incompatible habitats on and around the airport, and also accounts for the current mitigation efforts for such habitat.

Figure 13: Habitat Adjustment-Mitigated Score

This adjustment value is multiplied by the Aggregate Wildlife Risk Score to obtain the Overall Aggregate Wildlife Risk Score Adjusted for Habitat (Figure 14). Habitat Adjustment – Mitigated scores less than 1 reduce the risk and Habitat Adjustment – Mitigated scores greater than 1 increase the risk due to the increased attraction for wildlife.

Figure 14: Overall Aggregate Wildlife Risk Score Adjusted for Habitat

Aggregate Wildlife Risk Score Adjusted for Habitat	2.5034

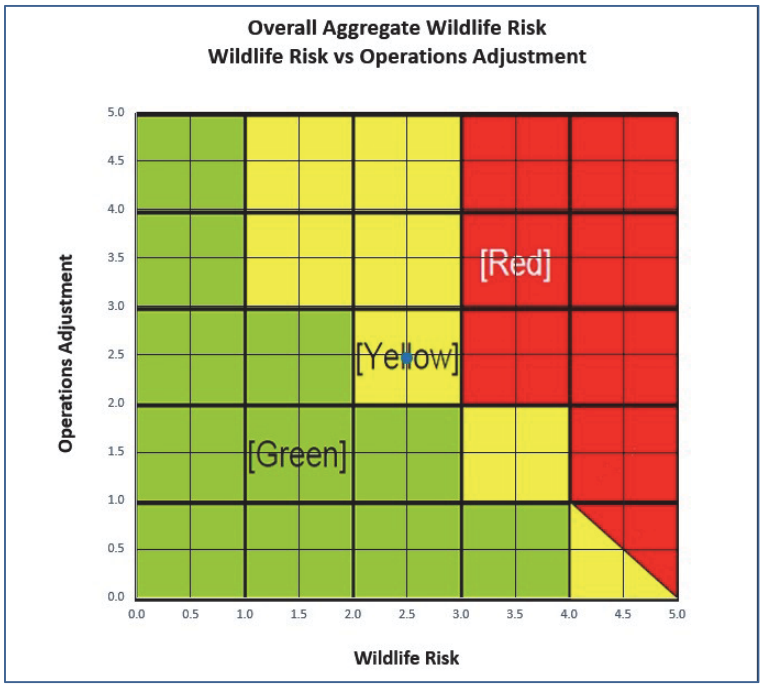
The final adjustment to the Aggregate Wildlife Risk Score is the Operations Adjustment (Figure 15). This value is based on the average number of monthly operations for the airport as compared to the average of 515 U.S. airports in FAA's Air Traffic Activity Data System (ATADS) database. Monthly operations greater than the average will have an Operations Adjustment greater than 1, and monthly average operations less than the average will have an Operations Adjustment less than 1. This Operations Adjustment is multiplied by the Aggregate Wildlife Risk Score Adjusted for Habitat to obtain the Overall Aggregate Wildlife Risk Score.

Figure 15: Operations Adjustment Score

Operations Adjustment	1.3054

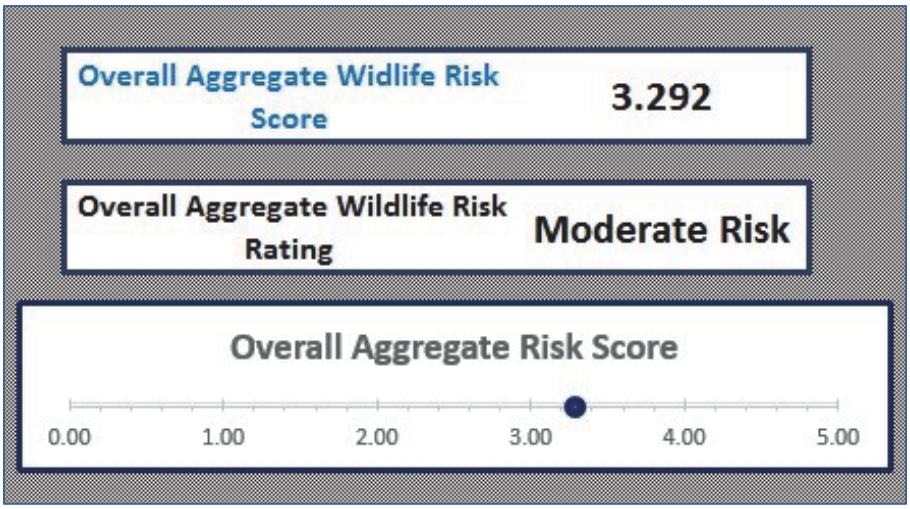
The second graph on the Results Worksheet graphically presents the relationship between wildlife risk and operations tempo. The example shown in Figure 16 shows the relationship between the two as a blue dot in the middle of the yellow (Moderate Risk) category. To move it to a lower risk rating would require a reduction in monthly airport operations, a reduction in the Aggregate Wildlife Risk Score, or a change in the Habitat Adjustment - Mitigated to decrease the Overall Aggregate Wildlife Risk Score Adjusted for Habitat.

Figure 16: Overall Aggregate Wildlife Risk vs. Operational Risk Matrix



The final result is the Overall Aggregate Wildlife Risk Score (Figure 17). The score is obtained by multiplying the Operations Adjustment by the Aggregate Wildlife Risk Score Adjusted for Habitat and assessed to determine a Low Risk, Moderate Risk, or High Risk situation for the airport. The score is graphically presented below the Overall Aggregate Wildlife Risk Score block. Below the graphical presentation is an information box that will post a message if the Habitat Adjustment has reached the minimum value that the WHaMRAT allows, indicating that additional habitat mitigation will not decrease risk.

Figure 17: Overall Aggregate, Final Rating, and Overall Risk Scores



EZ-Version Future-Projected Worksheet
Future-Projected Results

1.12 The EZ-Version WHaMRAT Future-Projected Results Worksheet

The Future-Projected Results worksheet provides the final overview of the future or projected wildlife risk condition at the airport based on the user input to all previous worksheets for both the current and future conditions (Figure 18). The results presented in this worksheet are consistent with those in the Results Worksheet except the calculations for the numerical columns are based on user input for future habitat and wildlife mitigation and future monthly aircraft operations.

This information is valuable if potential changes in seasonal wildlife abundance, aircraft operations and/or aircraft class, habitat presence and/or absence, habitat mitigation, and wildlife mitigation are anticipated or planned. For the user, this worksheet is optional; it is not required to use the WHaMRAT. It provides both graphical and numeric summaries of wildlife risk, as well as the effects of operations tempo and aircraft class, and habitat and wildlife mitigations on wildlife risk. An additional table that compares the current state versus the future condition is provided. This comparative information can be invaluable in determining the overall change in wildlife risk associated with projected actions, and it removes the necessity for users to go between the Results Worksheet and Future-Projected Worksheet to assess how projected changes impact the overall risk.

Figure 18: The EZ-Version WHaMRAT Future-Projected Results Worksheet

1.13 Summary

The goal in the development of the EZ-Version WHaMRAT was to allow universal application to all airport or wildlife staff, regardless of airport size and airport operations experience. It is best practice for all airport or wildlife staff to use the EZ-Version WHaMRAT initially. If a more experienced user with comprehensive wildlife data desires more detailed user input and potential evaluation capabilities, the Advanced-Version of the WHaMRAT is available for such users. Nevertheless, the EZ-Version WHaMRAT provides valuable information and utility to all airports and provides a quantitative wildlife risk-based assessment of current and future scenarios for all users.

2.0 The Advanced-Version WHaMRAT

The primary difference between the two versions of the WHaMRAT is the greater ability in the Advanced-Version WHaMRAT to further discriminate species presence within wildlife guilds (severity and likelihood of strike) and associated wildlife mitigation efforts at the guild and species level. Specifically, in the EZ-Version WHaMRAT, a guild includes all species in a particular guild with the average body mass in that guild used to determine severity and the associated Wildlife Severity Score. The user then inputs current and future wildlife mitigation values based on these more generalized guilds. In the Advanced-Version WHaMRAT, each guild is further divided into categories that encompass body mass ranges in the guild, a design that results in greater discrimination within each guild. As a result, the user can input current and future wildlife mitigation efforts that may be targeted at species that fall within a specific body mass range category in each guild.

A two-page Quick Start Guide for the Advanced-Version WHaMRAT is included as Attachment 12. The information in the next section provides a general overview of airport operator input into the Advanced-Version WHaMRAT.

Advanced-Version Wildlife Data Worksheet
Wildlife Data User Input

2.1 The Advanced-Version WHaMRAT Wildlife Data Worksheet—Severity Overview

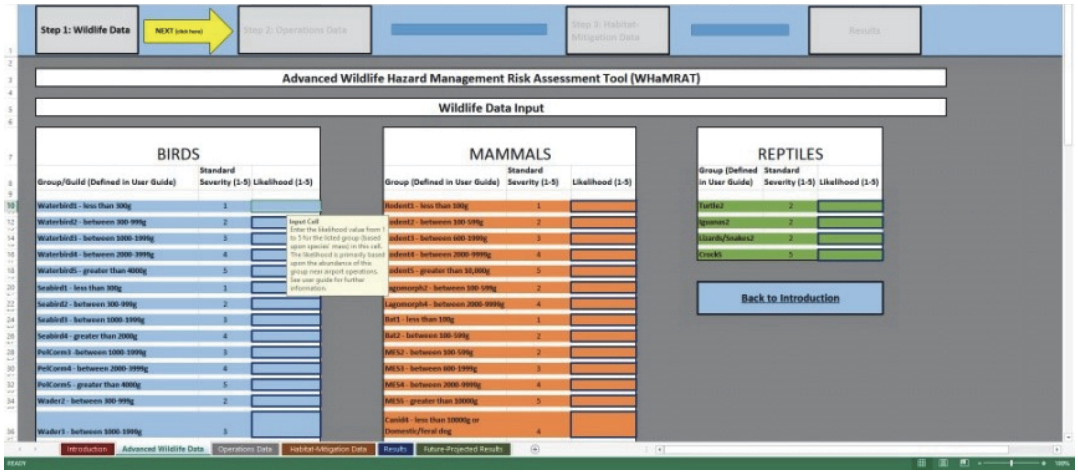
Assumptions:

- *Severity x Likelihood of Strike for 1 Guild = Wildlife Risk.* The cumulative Wildlife Risk scores of all guilds is the Aggregate Wildlife Risk.
- Wildlife severity is based solely on average body mass of each species within a specific guild. Guilds contain varied species that are detailed in Guild Designations (Attachment 1). Within each guild, there are five potential categories that are based on ranges of body mass in species within each guild (Attachments 4 and 5).
- Users identify species that are present, and those species are then placed into a specific body mass range category within each guild.

Wildlife Data Worksheet Explanation—Severity

Within the WHaMRAT, the user input for wildlife severity is an objective score ranging from 1 to 5 (whole numbers only) based solely on body mass (measured in grams) at the guild level for user-identified guilds present in the airport environment (Figure 19).

Figure 19: Advanced-Version Wildlife Data Worksheet



Guilds are defined as groups of species that exhibit common behavior, habitat use, and natural histories, but that are not necessarily taxonomically related. There is no current consensus for guild designations in the avian, mammalian, or reptilian literature and species were placed in the designations for the purposes of this application based on behavioral associations most often observed on or near airports. The guild designation and associated wildlife types within the WHaMRAT are detailed in Attachment 1. In the Advanced-Version WHaMRAT, any species that is contained within a specific guild will be further placed into a specific category based on body

mass within each guild (see Attachments 4, 5, 8, and 9). Because each body mass category represents a varying severity level ranging from 1 (low) to 5 (high), species-level input is provided by input of the species into a body mass category of each guild.

The WHaMRAT assigns a Severity Score to each species based on the appropriate five body mass categories within a specific guild detailed below. The Severity Score is not modifiable by the user. For example, if Green-winged Teal, Blue-winged Teal, and Wood Ducks (all in the Waterfowl Guild) are on the airport, each of these species has a Severity Score of 2 based on body mass and would be accounted for by the Waterfowl Guild 300-999g category. If the same airport also has Canada Geese (Severity Score of 4) under Waterfowl Guild 2000-3999g, and Tundra Swans (Severity Score of 5) under Waterfowl Guild > 4000g, the user would also input these species into their respective guild category to accurately account for all waterfowl species on the airport.

When species within a guild demonstrate flocking behavior or certain species within a guild are significantly larger in mass than most individual species within a guild, the WHaMRAT accounts for additional potential variation in the guild Severity Score. To account for flocking behavior, the Waders, Waterfowl, Shorebirds, Gulls/Terns, Doves/Pigeons, Corvids, and Blackbirds/Starlings Guilds can change Severity Score based on different flock sizes, with severity increasing as flock sizes increase. In the Upland Game Birds Guild, an increase in guild Severity Score occurs only if Wild Turkeys are present.

Wildlife Data Worksheet Explanation—Avian Guilds and Severity

In the Advanced-Version WHaMRAT, user input allows additional discrimination within avian guilds that are categorized by body mass. Avian Wildlife Severity Scores in the body mass category for each guild, including flocking adjustments to Severity Scores, are detailed in Table 3:

Table 3: Advanced-Version WHaMRAT, Avian Guilds and Severity Scores

Weights expressed in grams (g)

Guild	Severity
Waterbirds	
Waterbirds < 300g	**1**
Waterbirds 300-999g	**2**
Waterbirds 1000-1999g	**3**
Waterbirds 2000-3999g	**4**
Waterbirds > 4000g	**5**
Seabirds	
Seabirds < 300g	**1**
Seabirds 300-999g	**2**
Seabirds 1000-1999g	**3**
Seabirds 2000-3999g	**4**

(*continued on next page*)

Guild	Severity
Pelicans/Cormorants	
Pelicans 1000-1999g	**3**
Pelicans 2000-3999g	**4**
Pelicans > 4000g	**5**
Waders	
If flocks ≥ 5	**5**
Waders < 300g	**1**
Waders 300-999g	**2**
Waders 1000-1999g	**3**
Waders 2000-3999g	**4**
Waterfowl	
If flocks < 5	**4**
If flocks ≥ 5	**5**
Waterfowl 300-999g	**2**
Waterfowl 1000-1999g	**3**
Waterfowl 2000-3999g	**4**
Waterfowl > 4000g	**5**
Raptors/Vultures/Owls	
Raptors < 300g	**1**
Raptors 300-999g	**2**
Raptors 1000-1999g	**3**
Raptors 2000-3999g	**4**
Raptors > 4000g	**5**
Upland Game Birds	
Upland Game Birds < 300g	**1**
Upland Game Birds 300-999g	**2**
Upland Game Birds 1000-1999g	**3**
Upland Game Birds 2000-3999g	**4**
Upland Game Birds > 4000g	**5**
Cranes	**5**
Shorebirds	
If flocks < 20	**4**
If flocks ≥ 20	**5**
Shorebirds < 300g	**1**
Shorebirds 300-999g	**2**

(*continued on next page*)

Guild	Severity
Gulls/Terns	
If flocks < 10	**4**
If flocks ≥ 10	**5**
Gulls/Terns < 300g	**1**
Gulls/Terns 300-999g	**2**
Gulls/Terns 1000-1999g	**3**
Pigeons/Doves	
If flocks < 20	**4**
If flocks ≥ 20	**5**
Pigeons/Doves < 300g	**1**
Pigeons/Doves 300-999g	**2**
Parrots	
Parrots < 300g	**1**
Parrots 300-1000g	**2**
Aerial Foragers	**1**
Woodland Birds	**1**
Corvids	
If flocks < 15	**4**
If flocks ≥ 15	**5**
Corvids < 300g	**1**
Corvids 300-999g	**2**
Corvids 1000-1999g	**3**
Grassland Birds	**1**
Blackbirds/Starlings	**1**
If flocks < 100	**4**
If flocks ≥ 100	**5**
Miscellaneous	
Miscellaneous < 300g	**1**
Miscellaneous 300-999g	**2**
Criteria for Score	**Severity**
Less than 300g	**1**
300-999g	**2**
1000-1999g	**3**
2000-3999g	**4**
Greater than 4000g	**5**

Source: BASH Inc.

Wildlife Data Worksheet Explanation—Mammals and Reptiles

In the Advanced-Version WHaMRAT, user input allows additional discrimination by body mass within each mammalian and reptilian guild. However, threshold levels for severity by body mass for mammals and reptiles vary significantly from those for avian guilds, as aircraft will only encounter these animals (with the exception of bats) on the ground, and aircraft components that can be struck are less vulnerable to damage. Mammalian and reptilian Wildlife Severity Scores in the body mass category for each guild are detailed in Table 4:

Table 4: Advanced-Version WHaMRAT, Mammalian and Reptilian Guilds and Severity Scores

Weights expressed in grams (g)

Guild	Severity
Rodents	
Rodents < 100g	**1**
Rodents 100-599g	**2**
Rodents 600-1999g	**3**
Rodents 2000-9999g	**4**
Rodents > 10000g	**5**
Lagomorphs	
Lagomorphs 100-599g	**2**
Lagomorphs 2000-9999g	**4**
Bats	
Bats < 100g	**1**
Bats 100-599g	**2**
Mesomammals	
Mesomammals 100-599g	**2**
Mesomammals 600-1999g	**3**
Mesomammals 2000-9999g	**4**
Mesomammals > 10000g	**5**
Canids	
Canids 2000-9999g	**4**
Canids > 10000g	**5**
Felids	
Felids 600-1999g	**3**
Felids > 10000g	**5**
Hooved	
Hooved > 10000g	**5**
Bears	
Bears > 10000g	**5**

(*continued on next page*)

Guild	Severity
Turtles	2
Iguanas	2
Lizards/Snakes	2
Crocodiles/Alligators	5
Criteria for Score	**Severity**
0-99g	1
100-599g	2
600-1999g	3
2000-9999g	4
Greater than 10000g	5

Source: BASH Inc.

Advanced-Version Wildlife Data Worksheet
Wildlife Data User Input

2.2 The Advanced-Version WHaMRAT Wildlife Data Worksheet—Likelihood of Strike Overview

Assumptions:

- *Severity x Likelihood of Strike for 1 Guild = Wildlife Risk.* The cumulative Wildlife Risk scores of all guilds is the Aggregate Wildlife Risk.
- Wildlife Likelihood of Strike is based on estimates of abundance derived from objective wildlife observations contained in WHAs, WHSVs, or reference documents.

Wildlife Data Worksheet Explanation—Likelihood of Strike

Likelihood of Strike is a user-determined score based solely on the objective estimate of abundance of a particular wildlife species relative to airport operating surfaces. Airport or wildlife staff can determine the likelihood value for each guild and/or species previously identified for the severity user input based on estimated abundance data by guild and/or species reported in a WHA, WHSV, or in published literature. If such data do not exist, then the severity and likelihood value should be determined using abundance data from wildlife identification field guides or handbooks, or via Internet sources such as the USGS Northern Prairie Wildlife Research Center (accessed at http://www.npwrc.usgs.gov/). Most wildlife identification handbooks include information on range and seasonal presence of species, including observation rankings from "rare" to "abundant." The USGS Northern Prairie Wildlife Research Center also provides species lists and observation rankings for numerous wildlife refuges, wildlife areas, and so forth that may be in close proximity to a particular airport. Airport operators could extrapolate such data sources to make an educated estimate of species/guild presence and estimated abundance for their particular location and season. The following likelihood scores are recommended when using referenced sources that provide abundance information:

- Species not present at all: Likelihood Score = 0 (or cell left blank).
- Rare: Likelihood Score = 1.
- Uncommon: Likelihood Score = 2.
- Fairly Common: Likelihood Score = 3.
- Common: Likelihood Score = 4.
- Abundant: Likelihood Score = 5.

It cannot be overstated that the effectiveness of the WHaMRAT is predicated on appropriate assignments of Wildlife Severity and Likelihood of Strike scores. The cumulative effect of the aggregate Wildlife Severity and Likelihood of Strike scores determines an initial or current-state Aggregate Wildlife Risk Score (ranging from 1 to 5) for a particular airport. The remaining user inputs into subsequent worksheets in the WHaMRAT merely result in multiplicative adjustment or

correction factors and effects on this initial Aggregate Wildlife Risk Score that may result in an increase, decrease, or no effect on this Aggregate Wildlife Risk Score.

2.3 The Advanced-Version WHaMRAT Wildlife Data Worksheet—User Data Entry for Severity and Likelihood of Strike

Within this worksheet, users will:

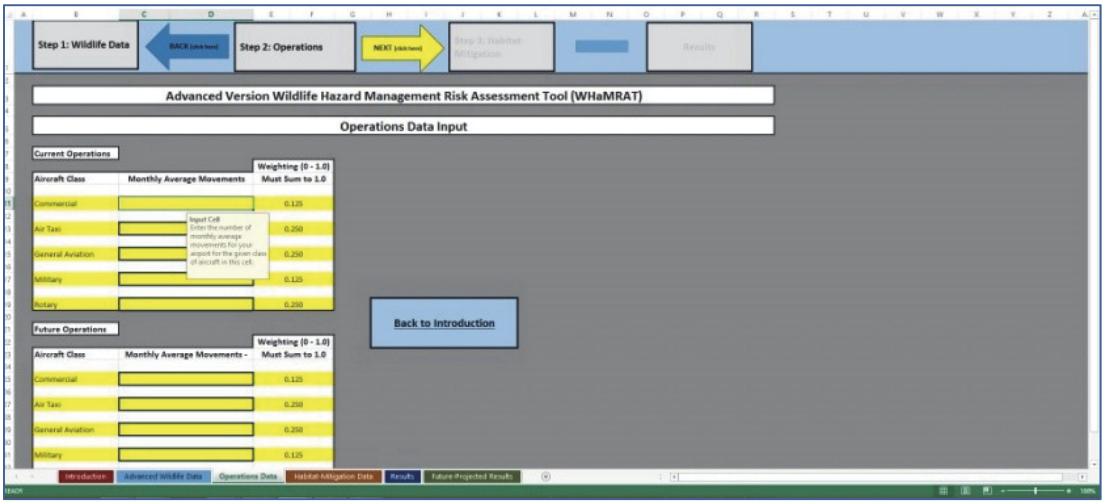
- Determine the presence of body mass categories of wildlife guilds using wildlife observation data provided by a WHA, WHSV, or pertinent literature. To determine appropriate body mass guild designation, users reference the guild designation information contained in Attachments 4 and 5. If information is available at the species level, species-level designations within guild body mass categories are contained in Attachments 8 and 9.
- For each body mass category of guilds identified, input a likelihood of strike score ranging from 1 to 5 (whole numbers only) based solely on estimates of abundance. If a body mass category of guilds is not identified, users leave the Likelihood of Strike Score blank for that specific body mass guild category. For example, if there are no waterfowl with a mass between 1000 and 1999 grams, the user would leave that waterfowl body mass category blank.

Advanced-Version Operations Data Worksheet
Operations Data User Input

2.4 The Advanced-Version WHaMRAT Operations Data Worksheet—Overview

By necessity, the process of user input to the Operations Data Worksheet in the Advanced-Version WHaMRAT is identical to that in the EZ-Version WHaMRAT (Figure 20).

Figure 20: The Advanced-Version WHaMRAT Operations Data Worksheet



Assumptions:

- An adjustment factor to the initial Aggregate Wildlife Risk Score is applied based on the average monthly number of aircraft movements as compared to the average monthly aircraft movements in airports across the United States.[3]
- The Operations Adjustment factor applied to the Aggregate Wildlife Risk Score accounts for monthly aircraft operations and aircraft class susceptibility to damage. This adjustment, combined with the Habitat and Mitigation adjustments, results in the Overall Aggregate Wildlife Risk Score.

2.5 The Advanced-Version WHaMRAT Operations Data Worksheet—User Data Entry for Aircraft Type and Tempo

Within this worksheet, users will:

- Determine the number of monthly airport operations by aircraft class.
- For each aircraft class, input the number of current monthly airport operations. If changes are expected in the number of operations by aircraft class, the user inputs this information into the future column of the worksheet. If no changes are expected, the user inputs the identical values that were input in the current monthly airport operations.

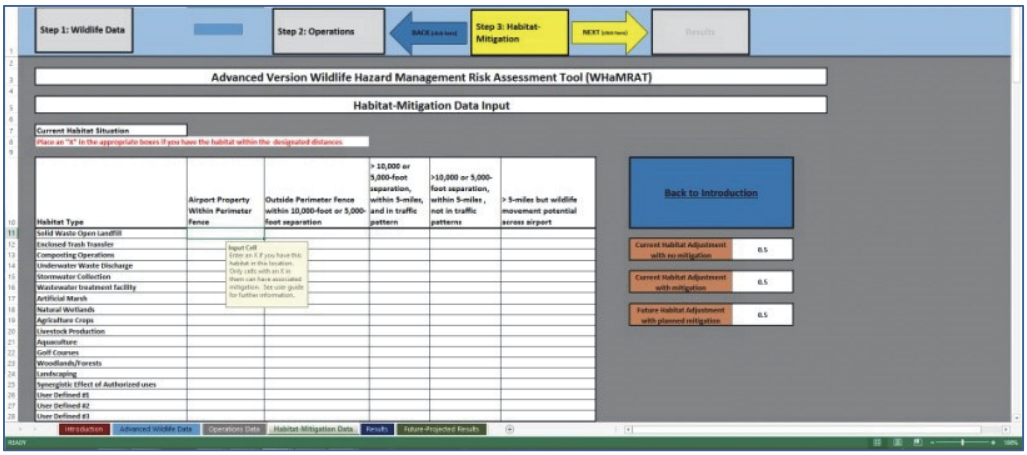
[3] Average number of aircraft operations at airports across the United States is taken from the FAA Air Traffic Activity Data System (ATADS) database containing the official NAS air traffic operations data.

Advanced-Version Habitat and Mitigation Worksheet
Habitat and Mitigation User Input

2.6 The Advanced-Version WHaMRAT Habitat and Mitigation Worksheet—Overview

The Habitat and Mitigation Worksheet in the Advanced-Version WHaMRAT is identical to that in the EZ-Version WhaMRAT (Figure 21). As with the Operations Data Worksheet, an identical approach to input habitat data is necessary. In addition, the input worksheet for current and future habitat mitigation associated with incompatible habitats also is identical in both versions of the WHaMRAT. However, the Advanced-Version WHaMRAT differs from the EZ-Version WHaMRAT in user input for current and future wildlife mitigation efforts targeted at specific guilds.

Figure 21: The Advanced-Version WHaMRAT Habitat and Mitigation Worksheet



Assumptions:

- An adjustment factor to the Aggregate Wildlife Risk Score is applied in the WHaMRAT based on the cumulative level of current habitat presence or absence specific to habitats that are incompatible with aircraft operations. This adjustment, combined with the Operations Adjustment, results in the Overall Aggregate Wildlife Risk Score.
- The habitat's effect on wildlife risk decreases as the distance from the airport property increases.
- Mitigation efforts are effective and reduce the impact of incompatible habitat(s).
- Increases in habitat mitigation will decrease wildlife risk, while decreases in habitat mitigation will increase wildlife risk.
- If a habitat has been completely mitigated, such as filling in a natural wetland, then that habitat no longer exists and an '*x*' should NOT be placed in that habitat row/column.

Habitat and Mitigation Worksheet Explanation—Habitat Presence or Absence and Mitigation (Current and Future)

The worksheet used to input incompatible habitat presence or absence in the Advanced-Version WHaMRAT is identical to that in the EZ-Version WHaMRAT. The worksheet used to input current and future habitat mitigation efforts associated with incompatible habitats is also identical in both versions of the WHaMRAT.

2.7 The Advanced-Version WHaMRAT Habitat and Mitigation Worksheet–User Data Entry for Habitat Presence or Absence

Within this worksheet, users will:

- Input data about the presence or absence of habitats that are considered incompatible with aircraft operations, as determined by consulting the airport master plan, combined with land use maps and habitat information of the surrounding area up to 5 miles from the airport property.
- Input the presence of incompatible habitats by placing an "*x*" in the cell for the appropriate habitat row specific to a column that indicates the distance from the airport property. If an incompatible habitat is not present, the user leaves this row and column cell blank.

2.8 The Advanced-Version WHaMRAT Habitat and Mitigation Worksheet—User Data Entry for Current Habitat Mitigation

Assumptions:

- If a habitat has been completely mitigated, such as filling in a natural wetland, then that habitat no longer exists and an '*x*' should NOT be placed in that habitat row/column.

Within this worksheet, users will:

- Determine the level of habitat mitigation currently in place for habitats identified by location from the airport property above. Input values will range from 1 (low), to 2 (moderate), to 3 (high) (whole numbers only).
- Input the level of current habitat mitigation for each incompatible habitat by placing a 1, 2, or 3 in the appropriate cell (habitat row and distance column). If no habitat mitigation is currently ongoing, the user leaves the appropriate cell blank. Similarly, if an incompatible habitat is not present, the user leaves this row and column cell blank.

2.9 The Advanced-Version WHaMRAT Habitat and Mitigation Worksheet—User Data Entry for Future Habitat Mitigation

Within this worksheet, users will:

- Determine the potential change in the level of future habitat mitigation for habitats identified by location from the airport property. Input values will range from 1 (low), 2 (moderate), and 3 (high) (whole numbers only).

- Input the level of future habitat mitigation for each incompatible habitat by placing a "1", "2", or "3" in the appropriate habitat row and distance column that indicates the distance from the airport property. If no future habitat mitigation change is planned, put an identical number into the appropriate habitat row and distance column as input during the current habitat mitigation. If a habitat mitigation change is planned, then put the appropriate value (ranging from 1 to 3) into the habitat row and distance column for that habitat. In addition, if an incompatible habitat is not present, leave this row and column cell blank.

Habitat and Mitigation Worksheet Explanation—Wildlife Mitigation by Guild (Current and Future)

The Advanced-Version WHaMRAT differs from the EZ-Version WHaMRAT in user input for current and future wildlife mitigation targeted at specific guilds. Because the guild categories are further differentiated by species in different body mass categories, the Advanced-Version WHaMRAT allows users to input wildlife mitigation levels that account for specific body mass categories within specific guilds.

Assumptions:

- An adjustment factor is applied to the Aggregate Wildlife Risk Score based on the cumulative level of current and future (planned) wildlife mitigation specific to guilds that are present and identified in the Wildlife Data Worksheet. This adjustment, combined with the Operations Adjustment, results in the Overall Aggregate Wildlife Risk Score.
- Current wildlife abundance is measured with current guild mitigation efforts in place. Therefore, current mitigations of certain guilds will not change the current Wildlife Risk Score. However, input of current mitigation levels against those guilds is required to correctly assess the impact of future mitigation efforts.
- One specific technique or method of wildlife mitigation may affect more than one guild. A combination of wildlife mitigation techniques or methods results in higher levels of wildlife mitigation for a specific guild.
- Increases in wildlife mitigation will decrease wildlife risk, whereas decreases in mitigation will increase wildlife risk.
- Wildlife mitigation techniques targeted at a particular species will be reflected in the user input with the associated guild category based on a specific body mass range.
- Future mitigation efforts should be at least the same level as current mitigation levels. Failure to maintain current mitigation levels and failure to input that level of mitigation into the future guild/species mitigation column will increase the Overall Aggregate Wildlife Risk Score.

2.10 The Advanced-Version WHaMRAT Habitat and Mitigation Worksheet—User Data Entry for Current Wildlife Mitigation by Guild

Within this worksheet, users will:

- Determine the level of wildlife mitigation currently in place for species within body mass guild categories present in the airport environment identified previously in Wildlife Data Worksheet. Input values will range from 1 (low), to 2 (moderate), to 3 (high) (whole numbers only).
- Input the level of current wildlife mitigation for each species within guild categories by placing a 1, 2, or 3 in the appropriate cell (the guild body mass category row under the current wildlife mitigation column). If no wildlife mitigation for a specific guild category is currently ongoing, the user leaves the appropriate cell blank.

2.11 The Advanced-Version WHaMRAT Habitat and Mitigation Worksheet—User Data Entry for Future Wildlife Mitigation by Guild

Within this worksheet, users will:

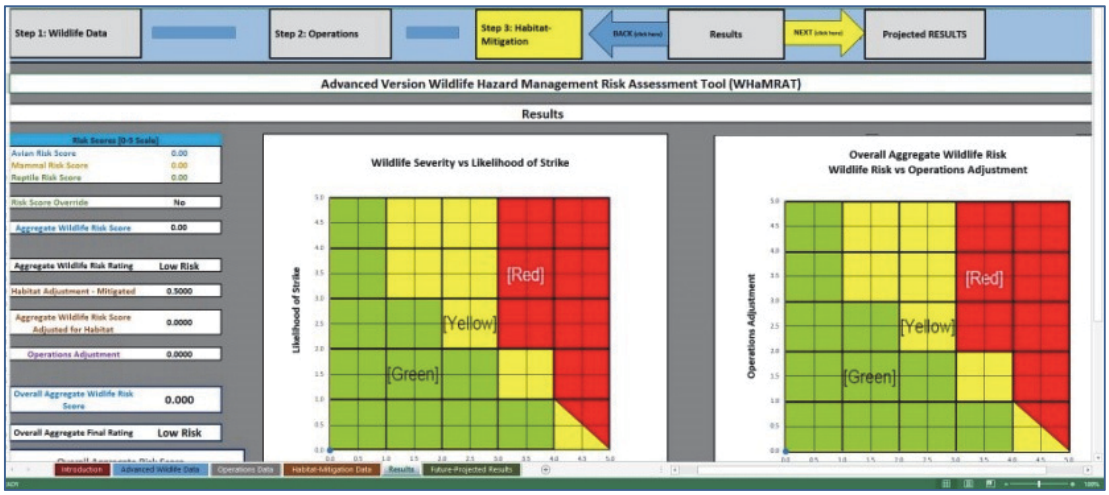
- Determine the potential change in the level of future wildlife mitigation for species within body mass guild categories present in the airport environment (identified previously in the Wildlife Data Worksheet). Input values will range from 1 (low), to 2 (moderate), to 3 (high) (whole numbers only).
- Input the level of future wildlife mitigation for each species within guild categories by placing a 1, 2, or 3 in the appropriate cell (the body mass guild row under the future wildlife mitigation column). If the level of future/planned wildlife mitigation will remain the same as the current level, the user places a value that is identical to the value placed in the current wildlife mitigation column. If the level of future wildlife mitigation will be different than the current conditions (increasing or decreasing), the user places the appropriate value in the future mitigation column. If no future wildlife mitigation is planned for a specific guild category, the user leaves the appropriate cell blank.

Advanced-Version Results Worksheet
Results

2.12 The Advanced-Version WHaMRAT Results Worksheet

The Advanced-Version WHaMRAT Results Worksheet provides the final overview of the current state of affairs relative to wildlife risk at the airport based on the user input to all previous worksheets relative to the current condition (Figure 22). It provides both graphical and numeric summaries of wildlife risk, and reflects the effects of monthly aircraft operations tempo and aircraft class, as well as habitat and wildlife mitigations, on wildlife risk.

Figure 22: The Advanced-Version WHaMRAT Results Worksheet



Advanced-Version Future-Projected Results Worksheet
Future-Projected Results

2.13 The Advanced-Version WHaMRAT Future-Projected Results Worksheet

The Future-Projected Results Worksheet provides the final overview of the future (projected) state of affairs relative to wildlife risk at the airport based on the user input to all previous worksheets for both the current and future conditions (Figure 23). For the user, this worksheet is optional; it is not required to use the WHaMRAT. This information is valuable if potential changes in seasonal wildlife abundance, monthly aircraft operations and/or aircraft class, habitat presence and/or absence, habitat mitigation, and wildlife mitigation are anticipated or planned. The Future-Projected Results Worksheet provides graphical and numeric summaries of wildlife risk, as well as the effects of operations tempo and aircraft type, and habitat and wildlife mitigations on wildlife risk. It compares the current state versus the future condition, and it can be invaluable in determining the overall change in wildlife risk associated with projected actions.

Figure 23: The Advanced-Version WHaMRAT Future-Projected Results Worksheet

2.14 Utility of the WHaMRAT

The Results and Future-Projected Results output worksheets of both versions of the WHaMRAT provide airport or wildlife staff with a comprehensive and accurate representation of wildlife risk based on wildlife severity and abundance, monthly aircraft operations tempo and aircraft class, potential habitat attraction at varying distances for the airport, and current and future wildlife management and control mitigation associated with habitat and wildlife. Prioritization and

application of future wildlife control and management mitigation should account for the current state of affairs while pursuing the goal of continuous reduction in wildlife risk. If mitigation is effective, then the net result should be a decrease in wildlife species/guilds present, combined with an associated reduction in the likelihood of wildlife strikes.

A depiction of changes in Overall Aggregate Wildlife Risk can be derived from the model output, and data from periodic entries into the WHaMRAT should be used at the individual airport level for trend analysis over time. Regardless of any single Overall Aggregate Wildlife Risk Score obtained from the WHaMRAT—whether it be low (green), moderate (yellow), or high (red)—the ultimate goal of all airport or wildlife staff is to continuously "drive the dot down and to the left" by reducing the airport's Overall Aggregate Wildlife Risk Score. This continuous process associated with the WHaMRAT is the essence of a Safety Management System (SMS).

3.0 The EZ-Version and Advanced-Version WHaMRAT Case Study Examples

The eight case studies provided in this section are intended to assist the user by profiling common situations that may exist on an airport relative to wildlife. Each case study provides a scenario, as well as the expected result within the WHaMRAT. Case Studies #1 through #7 apply to both the EZ-Version WHaMRAT and the Advanced-Version WHaMRAT. Case Study #8 is specific only to the Advanced-Version WHaMRAT. Each case study also has applications to an airport's Safety Management System (SMS). In Case Study #1, the SMS applications are detailed. For brevity, the SMS information is not repeated in Case Studies #2 through #8; nevertheless, users should consider the SMS applications relative to wildlife risk to include:

- Cause
- Hazard
- Effect/Consequence
- Existing Controls
- Mitigations
- Trending

ACRP Case Study #1—Seasonal Flocking Behavior

Model Behavior: Change in Aggregate Wildlife Risk Score associated with a change in severity and possible likelihood of strike when species demonstrate seasonal flocking behavior.

Scenario: Airport A has members of the Blackbird/Starling Guild year round. In the summer, members of this guild demonstrate solitary/individual or possibly pair-bonded behavior. However, in the winter, this guild demonstrates significant flocking behavior. The result of this flocking behavior is an increase in associated severity (greater number of individuals and higher overall biomass), as well as a probable increase in likelihood of strike (greater abundance). The net result may be an increase in overall severity and likelihood of a strike.

Model Result: The model will increase risk due to this scenario if the user inputs seasonal variance in likelihood scores. Because flocking increases overall biomass (severity) and abundance (likelihood of strike), the airport will have higher wildlife risk in the winter than in the summer relative to the Blackbirds/Starlings Guild.

Cause: Winter changes in Blackbird/Starling Guild behavior.

Hazard: Blackbird/starling flocking.

Effect/Consequence: Increased probability and severity of bird strikes.

Existing Controls: Hazing, habitat management, other.

Mitigations: What additional mitigations would a wildlife or airport manager use to manage the increased risk?

Trending: Have prior year mitigations (list or describe) managed the potential risk?
Is this the first occurrence of the behavior?

Key concepts:

Hazard: *Any real or potential condition that can cause injury, illness, or death to people; damage to or loss of a system, equipment, or property; or damage to the environment.*

Cause: *Events that lead to or result in a hazard or hazardous condition.*

Effect or Consequence: *Outcome or harm of a hazard for a given system state.*

ACRP Case Study #2—Changes in Guilds Present

Model Behavior: Change in Aggregate Wildlife Risk Score associated with a reduction of a higher severity guild/species with an associated population increase in lower severity guild species, even though there may be an overall increase in total species abundance (likelihood of strike).

Scenario: Airport A has members of two guilds: one considered higher severity such as Canada Geese (Waterfowl); and another considered lower severity such as Western Meadowlarks (Grassland Birds). Airport wildlife control and management efforts manipulate the habitat (filled an on-airport pond and replaced with grassland turf) that eliminates the Canada Geese presence on the airport. However, the habitat manipulation increases suitable habitat for Western Meadowlarks and that ecological niche is filled by an increase in the Western Meadowlark population on the airport property.

Model Result: The model will not necessarily result in an increase in the Aggregate Wildlife Risk Score due to this scenario. Although abundance (likelihood of strike) may increase as higher numbers of Western Meadowlarks are present on the airport property, the associated wildlife risk may actually decrease because the Western Meadowlarks have a lower overall Severity Score than Canada Geese. However, if Western Meadowlarks reach high enough abundance in the absence of Canada Geese, the overall biomass may be greater than the Canada Geese biomass and the Aggregate Wildlife Risk Score could increase.

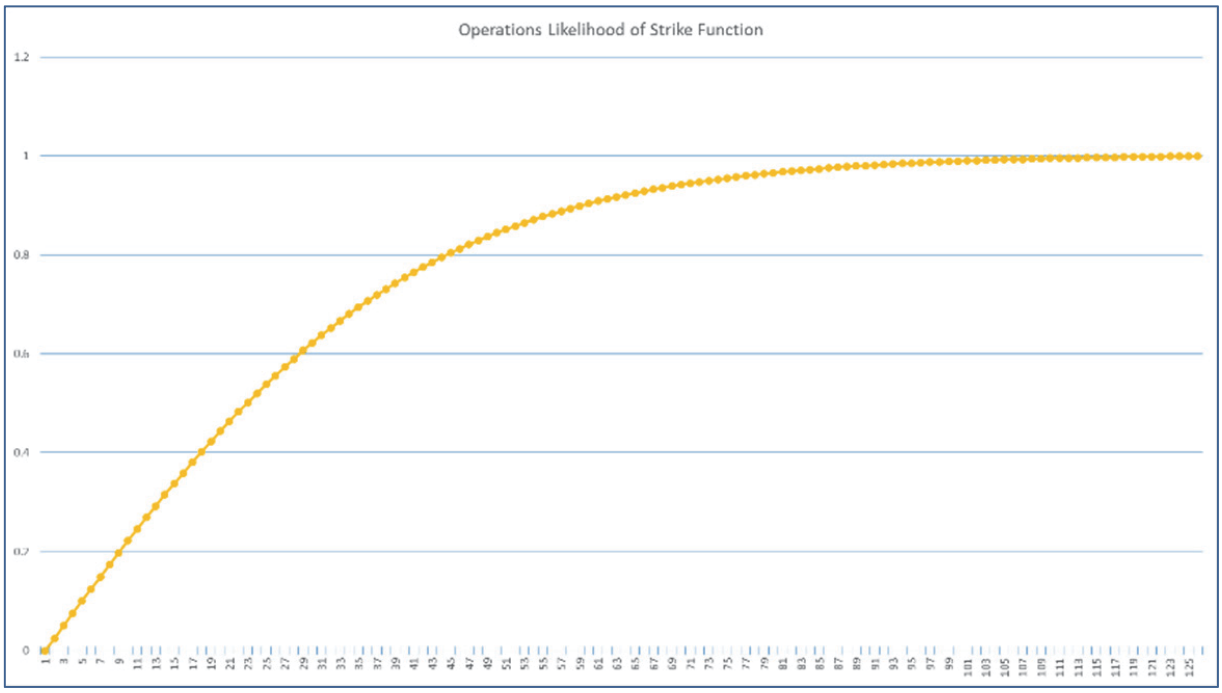
ACRP Case Study #3—Change in Airport Operations Tempo

Model Behavior: Change in Overall Aggregate Wildlife Risk Score associated with a change in operations tempo.

Scenario: Airport A increases its number of take-offs/landings. This could be the result of adding or modifying a runway, or increasing the number of aircraft movements due to adding a new carrier, or additional operations each day. The increased movements will increase the associated Overall Aggregate Wildlife Risk due to an increase in likelihood of strikes associated with the increased operations tempo.

Model Result: The model will depict an increase in the Overall Aggregate Wildlife Risk Score due to this scenario. However, the increase in the probability of likelihood of strike will not increase linearly as demonstrated in Figure 24. As movements continue to increase, there will be a level of activity where the potential risk plateaus or the rate of change in likelihood of strike is reduced.

Figure 24: Operations Likelihood of Strike Function



ACRP Case Study #4—Change in Incompatible Habitat On- or Off-Airport

Model Behavior: Change in Overall Aggregate Wildlife Risk Score associated with a change in habitat on or off-airport that influences the wildlife use of a particular habitat/location.

Scenario: Through wildlife control and management activities, certain habitats are modified or changed to a different habitat. One example may be that an off-airport landfill is closed and replaced with a new land use consistent with other habitat in that area. Another example may be that an on-airport retention pond is modified with bird balls or a non-jurisdictional wetland is removed. In such cases, the removal or modification of preferred habitat results in an overall decrease in wildlife attraction. In turn, severity and likelihood of strike decreases; thus reducing the Overall Aggregate Wildlife Risk Score.

Model Result: The model will depict a decrease in the Overall Aggregate Wildlife Risk Score due to this scenario. Wildlife control and management actions associated with habitat that reduce overall wildlife attraction will result in a reduction of severity, as well as a reduction in likelihood of strike (decreased abundance). However, if the habitat is replaced/modified with a new/different habitat that is actually more attractive to wildlife, then the result may be more wildlife biomass (severity) and abundance (likelihood of strike) that result in an increase in the Overall Aggregate Wildlife Risk Score. An example of such may be that a golf course is built that replaces native habitat in the area.

ACRP Case Study #5—Change in Habitat Mitigation on Airport Property

Model Behavior: Change in Overall Aggregate Wildlife Risk Score associated with a change in incompatible habitat on the airport property.

Scenario: An airport currently conducts agriculture on its airport property. The airport decides to discontinue agriculture and return such land to managed turf conditions.

Any habitat considered incompatible with aircraft operations (agriculture) on the airport will result in an increased Overall Aggregate Wildlife Risk due to that habitat's presence. The WHaMRAT model multiplies the current Overall Aggregate Wildlife Risk Score by an adjustment factor associated with such habitat's presence and/or absence. The magnitude of the adjustment factor is influenced by the distance of the habitat from the airport property. Because the agriculture was occurring on the airport property, this adjustment factor is significant.

Model Result: The model will depict a decrease in the Overall Aggregate Wildlife Risk Score due to this scenario. Because agriculture is no longer present on the airport, the user input will remove agriculture from such habitats. The resulting adjustment factor will also decrease. Over time, one would also expect a potential decrease in species/guild presence on the airport, as well and a reduction in number of individuals and estimated abundance. These reductions in abundance will most likely also result in a reduction of potential likelihood of wildlife strikes from the affected species. If such a reduction in species and abundance is confirmed by the airport after the removal of agriculture, during the next iteration of user input into the Wildlife Data Worksheet (likelihood), the user should reduce the likelihood score for a particular guild or even potentially remove it as a species and/or guild of concern.

ACRP Case Study #6—Change in Wildlife Mitigation Targeted at a Specific Guild

Model Behavior: Change in Overall Aggregate Wildlife Risk Score associated with a change in mitigation targeted at a specific guild on the airport property.

Scenario: An airport currently does not have a security perimeter fence. The airport installs a security perimeter fence that complies with recommendations per FAA Advisory Circular 150/5200-33B and CertAlert 14-16.

Any airport that does not have a security perimeter fence surrounding its property will have a potential for greater number of species and/or guilds on their airport. In addition, wildlife will occur in higher abundance and create a higher potential for wildlife strikes. This is especially true for mammalian and reptilian guilds, and in particular with larger mammals such as White-tailed Deer, Mule Deer, Elk, Moose, Coyotes, and Mesomammals. The WHaMRAT model multiplies the current Aggregate Wildlife Risk Score by an adjustment factor associated with wildlife mitigation. The magnitude of the adjustment factor is influenced by the mitigation effort for a particular habitat and or a particular species/guild. Because no mitigation (security perimeter fence) is currently in place, the mitigation for such guilds would be less than if a fence was in place, and the adjustment factor will be greater.

Model Result: Once the security perimeter fence is installed, the model will depict a decrease in the Overall Aggregate Wildlife Risk Score due to this scenario. Because a security perimeter fence is now in place, the user input will increase its mitigation estimate for those guilds affected by such an exclosure. Because a security perimeter fence is very effective in precluding such guilds from entering the airport property, this mitigation effort combined with potential harassment and lethal removal (if necessary), and the resulting user input will increase mitigation for such guilds. The resulting adjustment factor will also decrease and reduce the Overall Aggregate Wildlife Risk Score. One would also expect a reduction in such guilds on the airport property and a decrease in estimated abundance over time. These reductions in abundance will most likely also result in a reduction of potential likelihood of a wildlife strike from the affected species. If such a reduction in species and abundance is confirmed by the airport after the addition of a security perimeter fence, during the next iteration of user input into the Wildlife Data Worksheet (likelihood), the user should reduce the likelihood score for the affected guilds or even potentially remove them as species and/or guilds of concern.

ACRP Case Study #7—Change in Wildlife Mitigation on Airport Infrastructure

Model Behavior: Change in Overall Aggregate Wildlife Risk Score associated with a change in wildlife mitigation associated with infrastructure on the airport property.

Scenario: An airport notices increasing perching behavior, particularly with Red-tailed Hawks, American Kestrels, and Eastern Meadowlarks on runway edge lighting, runway approach lights, and varied antennas and structures on or in close proximity to the operating surfaces. Currently, there is no infrastructure deterrent mitigation in place on the airport. In response to this increasing potential for wildlife strikes, the airport increases its deterrent methods to include installing anti-perching devices on numerous perching locations.

Based on wildlife observations, this increased mitigation activity is primarily targeting members of the Raptors/Vultures/Owls and Grassland Birds Guilds. The user would input an increased score into the wildlife mitigation cells for at least the Raptors/Vultures/Owls and Grassland Birds Guilds, and possibly other guilds if members of the guild were observed behaving in a similar manner. The WHaMRAT model multiplies the current Overall Aggregate Wildlife Risk Score by an adjustment factor associated with the increased wildlife mitigation. The magnitude of the adjustment factor is influenced by score input by the user, ranging from 1 to 3.

Model Result: The model will depict a decrease in the Overall Aggregate Wildlife Risk Score due to this scenario. After the installation of the anti-perching devices, if wildlife activities are decreased, then the mitigation is effective. Over time, one may also observe a potential decrease in species/guild presence on the airport due to the lack of perching locations, as well and a reduction in number of individuals and estimated abundance. These reductions in abundance will most likely result in a reduction of potential likelihood of wildlife strikes from the affected species. If such a reduction in species and abundance is confirmed by the airport, during the next iteration of user input into Wildlife Data Worksheet (likelihood), the user should reduce the likelihood score for a particular guild or even potentially remove it as a species and/or guild of concern.

ACRP Case Study #8—User Input of Wildlife Identified at the Species Level

(Case Study Example Pertinent to the Advanced-Version WHaMRAT)

Model Behavior: Input of wildlife at the species level and the associated user input of likelihood in the Advanced-Version of WHaMRAT providing more resolute discrimination of risk within guilds.

Scenario: Within the Waterfowl Guild, an airport identifies the following species of waterfowl: 1) Blue-winged Teal; 2) Green-winged Teal; 3) Wood Duck; 4) Common Merganser; 5) Redhead; 6) Mallard; 7) Canada Goose; and 8) Tundra Swan.

The Advanced-Version of WHaMRAT allows airport or wildlife staff to input species-level information into the Wildlife Data Worksheet for severity and likelihood. Based on the above species mix, the user will have to identify each species in their specific guild category that is based on a body mass range as identified in Attachment 8. In the above species example: Blue-winged Teal, Green-winged Teal, and Wood Duck would be input into the Waterfowl 300-999g guild category with an associated Severity Score of 2. Common Merganser, Redhead, and Mallard would be input into the Waterfowl 1000-1999g category with a Severity Score of 3. Canada Goose would be input into the Waterfowl 2000-3999g category with a Severity Score of 4. Lastly, Tundra Swan would be input into the Waterfowl >4000g category with a Severity Score of 5. These severity values for each category within a guild are contained within WHaMRAT. For each guild category, a user input for likelihood of strike is also necessary. Using estimated abundance to determine likelihood of strike, the user will have to assign a likelihood of strike relative to those species within the specific guild. A likelihood of strike score ranging from 1 to 5 is required for each category within a guild and in this case includes Waterfowl 300-999g, Waterfowl 1000-1999g, Waterfowl 2000-3999g, and Waterfowl >4000g. In guilds where there is only one representative species observed, the likelihood of strike score is based on that particular species. In a guild that contains multiple species, such as this scenario, the user must enter a likelihood of strike score that represents all species within this guild and will require inputs into more than one mass category within the guild.

Model Result: Similar to the EZ-Version WHaMRAT, the Advance-Version of WHaMRAT will determine an Aggregate Wildlife Risk Score based on the guild categories present and their associated likelihood of strikes. The Advanced-Version allows the user a higher degree of discrimination associated with specific species within their airport environment. However, the WHaMRAT is limited in its ability to discriminate all species and requires the user to compile species within a particular body mass category for each specific guild.

Attachment 1: Avian and Non-Avian Guilds Used in the WHaMRAT

Avian Guilds

1) **Waterbirds** – Loons, Grebes, Coots, Limpkins, Rails, Moorhens, Gallinules, Crakes
2) **Seabirds** – Albatrosses, Petrels, Shearwaters, Fulmars, Kittiwakes, Alcids, Storm-petrels, Frigatebirds, Tropicbirds, Boobies, Noddies
3) **Pelicans/Cormorants** – Pelicans, Cormorants, Anhingas
4) **Waders** – Herons, Egrets, Ibises, Flamingos, Storks, Bitterns, Spoonbills
5) **Waterfowl** – Ducks, Geese, Swans
6) **Raptors/Vultures/Owls** – Vultures, Condors, Eagles, Ospreys, Kites, Hawks, Caracaras, Falcons, Owls
7) **Upland Game Birds** – Chachalacas, Turkeys, Quail, Grouse, Ptarmigans, Prairie Chickens, Pheasants, Chukars, Partridges
8) **Cranes** – Sandhill and Whooping Cranes
9) **Shorebirds** – Plovers, Oystercatchers, Avocets, Stilts, Sandpipers, Snipes, Phalaropes
10) **Gulls/Terns** – Gulls, Terns, Skuas, Skimmers
11) **Pigeons/Doves** – Pigeons, Doves, Ground Doves
12) **Parrots** – Parrots, Amazons, Parakeets, Trogons
13) **Aerial Foragers** – Nighthawks, Poor-wills, Swifts, Swallows, Martins
14) **Woodland Birds** – Hummingbirds, Cuckoos, Woodpeckers, Most Flycatchers, Shrikes, Vireos, Chickadees, Nuthatches, Wrens, Warblers, Thrushes, Mockingbirds, Thrashers, Catbirds, Waxwings, Tanagers, Towhees, Most Buntings, Most Sparrows, Juncos, Grosbeaks, Cardinals, Orioles, Finches, Crossbills
15) **Corvids** – Jays, Nutcrackers, Magpies, Crows, Ravens
16) **Grassland Birds** – Horned Larks, Most Pipits, Meadowlarks, Some Sparrows (Grasshopper, Vesper, Savannah, Clay-colored, Henslow's, etc.) Longspurs, Snow Buntings, Bobolinks, Lark Buntings
17) **Blackbirds/Starlings** – European Starlings, Blackbirds, Grackles, Cowbirds, Anis
18) **Miscellaneous** – Roadrunners, Kingfishers, Dippers, Others.

Non-Avian Guilds

Mammals

1) **Rodents** – Beavers, Squirrels, Rats, Mice, Ground Squirrels, Shrews, Prairie Dogs, Marmots, Chipmunks, Pocket Gophers, Voles, Lemmings
2) **Lagomorphs** – Rabbits, Hares, Pikas
3) **Bats** – Bats
4) **Mesomammals** – Opossums, Armadillos, Weasels, Minks, Martins, Wolverines, Badgers, Otters, Skunks, Raccoons
5) **Canids** – Coyotes, Wolves, Foxes, Domestic Dogs
6) **Felids** – Bobcats, Lynxes, Mountain Lions, Feral Cats
7) **Hooved** – Horses, Hogs/Pigs, Deer, Elk, Moose, Caribou, Antelope, Sheep
8) **Bears** – Bears

Reptiles/Amphibians

1) **Alligators/Crocodiles** – Alligators, Crocodiles
2) **Turtles** – Turtles, Tortoises
3) **Iguanas** – Iguanas
4) **Lizards/Snakes** – Smaller Lizards and Most Snakes

Attachment 2: The EZ-Version WHaMRAT Avian Guild and Severity Scores

Weights expressed in grams (g)

Guilds	Severity
Waterbirds	2
Seabirds	2
Pelicans/Cormorants	4
Waders	2
If flocks ≥ 5	5
Waterfowl	3
If flocks < 5	4
If flocks ≥ 5	5
Raptors/Vultures/Owls	2
Upland Game Birds	2
If Turkeys	5
Cranes	5
Shorebirds	1
If flocks < 15	4
If flocks ≥ 15	5
Gulls/Terns	2
If flocks < 10	4
If flocks ≥ 10	5
Pigeons/Doves	1
If flocks < 20	4
If flocks ≥ 20	5
Parrots	1
Aerial Foragers	1
Woodland Birds	1
Corvids	2
If flocks < 10	4
If flocks ≥ 10	5
Grassland Birds	1
Blackbirds/Starlings	1
If flocks < 100	4
If flocks ≥ 100	5
Miscellaneous	1
Criteria for Score	**Severity**
Less than 300g	1
300-999g	2
1000-1999g	3
2000-3999g	4
Greater than 4000g	5

Source: BASH Inc.

Attachment 3: The EZ-Version WHaMRAT Mammalian and Reptilian Guild and Severity Scores

Weights expressed in grams (g)

Guilds	Severity
Rodents	2
Lagomorphs	4
Bats	1
Mesomammals	4
Canids	5
Felids	5
Hooved	5
Bears	5
Turtles	2
Iguanas	2
Lizards/Snakes	2
Crocodiles/Alligators	5
Criteria for Score	**Severity**
0-99g	1
100-599g	2
600-1999g	3
2000-9999g	4
Greater than 10000g	5

Source: BASH Inc.

Attachment 4: Advanced-Version Avian Guild and Severity Scores

Weights expressed in grams (g)

Guild	Severity
Waterbirds	
Waterbirds < 300g	**1**
Waterbirds 300-999g	**2**
Waterbirds 1000-1999g	**3**
Waterbirds 2000-3999g	**4**
Waterbirds > 4000g	**5**
Seabirds	
Seabirds < 300g	**1**
Seabirds 300-999g	**2**
Seabirds 1000-1999g	**3**
Seabirds 2000-3999g	**4**
Pelicans/Cormorants	
Pelicans 1000-1999g	**3**
Pelicans 2000-3999g	**4**
Pelicans > 4000g	**5**
Waders	
If flocks ≥ 5	**5**
Waders 300-999g	**2**
Waders 1000-1999g	**3**
Waders 2000-3999g	**4**
Waders > 4000g	**5**
Waterfowl	
If flocks < 5	**4**
If flocks ≥ 5	**5**
Waterfowl 300-999g	**2**
Waterfowl 1000-1999g	**3**
Waterfowl 2000-3999g	**4**
Waterfowl > 4000g	**5**
Raptors/Vultures/Owls	
Raptors < 300g	**1**
Raptors 300-999g	**2**
Raptors 1000-1999g	**3**
Raptors 2000-3999g	**4**
Raptors > 4000g	**5**
Upland Game Birds	
Upland Game Birds < 300g	**1**
Upland Game Birds 300-999g	**2**
Upland Game Birds 1000-1999g	**3**
Upland Game Birds 2000-3999g	**4**
Upland Game Birds > 4000g	**5**
Cranes	**5**

(*continued on next page*)

Guild	Severity
Shorebirds	
If flocks < 20	**4**
If flocks ≥ 20	**5**
Shorebirds < 300g	**1**
Shorebirds 300-999g	**2**
Gulls/Terns	
If flocks < 10	**4**
If flocks ≥ 10	**5**
Gulls/Terns < 300g	**1**
Gulls/Terns 300-999g	**2**
Gulls/Terns 1000-1999g	**3**
Pigeons/Doves	
If flocks < 20	**4**
If flocks ≥ 20	**5**
Pigeons/Doves < 300g	**1**
Pigeons/Doves 300-999g	**2**
Parrots	
Parrots < 300g	**1**
Parrots 300-999g	**2**
Parrots 1000-3999g	**3**
Aerial Foragers	**1**
Woodland Birds	**1**
Corvids	
If flocks < 15	**4**
If flocks ≥ 15	**5**
Corvids < 300g	**1**
Corvids 300-999g	**2**
Corvids 1000-1999g	**3**
Grassland Birds	**1**
Blackbirds/Starlings	**1**
If flocks < 100	**4**
If flocks ≥ 100	**5**
Miscellaneous	
Miscellaneous < 300g	**1**
Miscellaneous 300-999g	**2**
Criteria for Score	**Severity**
Less than 300g	**1**
300-999g	**2**
1000-1999g	**3**
2000-3999g	**4**
Greater than 4000g	**5**

Source: BASH Inc.

Attachment 5: The Advanced-Version WHaMRAT Mammalian Guild and Severity Scores

Weights expressed in grams (g)

Guild	Severity
Rodents	
Rodents < 100g	**1**
Rodents 100-599g	**2**
Rodents 600-1999g	**3**
Rodents 2000-9999g	**4**
Rodents > 10000g	**5**
Lagomorphs	
Lagomorphs 100-599g	**2**
Lagomorphs 2000-9999g	**4**
Bats	
Bats < 100g	**1**
Bats 100-600g	**2**
Mesomammals	
Mesomammals 100-599g	**2**
Mesomammals 600-1999g	**3**
Mesomammals 2000-9999g	**4**
Mesomammals > 10000g	**5**
Canids	
Canids 2000-9999g	**4**
Canids > 10000g	**5**
Felids	
Felids 600-1999g	**3**
Felids > 10000g	**5**
Hooved	
Hooved > 10000g	**5**
Bears	
Bears > 10000g	**5**
Criteria for Score	**Severity**
0-99g	**1**
100-599g	**2**
600-1999g	**3**
2000-9999g	**4**
Greater than 10000g	**5**

Source: BASH Inc.

Attachment 6: The EZ-Version WHaMRAT Avian Species List by Guild and Severity Score

Waterbirds	Severity
Individual	**3**
Common Name	**Scientific Name**
Red-throated Loon	*Gavia stellata*
Arctic Loon	*Gavia arctica*
Pacific Loon	*Gavia pacifica*
Common Loon	*Gavia immer*
Yellow-billed Loon	*Gavia adamsii*
Least Grebe	*Tachybaptus dominicus*
Pied-billed Grebe	*Podilymbus podiceps*
Horned Grebe	*Podiceps auritus*
Red-necked Grebe	*Podiceps grisegena*
Eared Grebe	*Podiceps nigricollis*
Western Grebe	*Aechmophorus occidentalis*
Clark's Grebe	*Aechmophorus clarkii*
Yellow Rail	*Coturnicops noveboracensis*
Black Rail	*Laterallus jamaicensis*
Corn Crake	*Crex crex*
Ridgway's Rail	*Rallus obsoletus*
Clapper Rail	*Rallus crepitans*
King Rail	*Rallus elegans*
Virginia Rail	*Rallus limicola*
Rufous-necked Wood-Rail	*Aramides axillaris*
Gray-necked Wood-Rail	*Aramides cajaneus*
Sora	*Porzana carolina*
Paint-billed Crake	*Neocrex erythrops*
Spotted Rail	*Pardirallus maculatus*
Purple Swamphen	*Porphyrio porphyrio*
Purple Gallinule	*Porphyrio martinicus*
Azure Gallinule	*Porphyrio flavirostris*
Common Gallinule	*Gallinula galeata*
Common Moorhen	*Gallinula chloropus*
Eurasian Coot	*Fulica atra*
Hawaiian Coot	*Fulica alai*
American Coot	*Fulica americana*
Sungrebe	*Heliornis fulica*

(*continued on next page*)

Seabirds	Severity
Individual	**2**
Common Name	**Scientific Name**
Yellow-nosed Albatross	*Thalassarche chlororhynchos*
White-capped Albatross	*Thalassarche cauta*
Salvin's Albatross	*Thalassarche salvini*
Chatham Albatross	*Thalassarche eremita*
Black-browed Albatross	*Thalassarche melanophris*
Wandering Albatross	*Diomedea exulans*
Light-mantled Albatross	*Phoebetria palpebrata*
Laysan Albatross	*Phoebastria immutabilis*
Black-footed Albatross	*Phoebastria nigripes*
Short-tailed Albatross	*Phoebastria albatrus*
Southern Giant-Petrel	*Macronectes giganteus*
Northern Fulmar	*Fulmarus glacialis*
Great-winged Petrel	*Pterodroma macroptera*
Providence Petrel	*Pterodroma solandri*
Zino's Petrel	*Pterodroma madeira*
Kermadec Petrel	*Pterodroma neglecta*
Trindade Petrel	*Pterodroma arminjoniana*
Murphy's Petrel	*Pterodroma ultima*
Mottled Petrel	*Pterodroma inexpectata*
Bermuda Petrel	*Pterodroma cahow*
Black-capped Petrel	*Pterodroma hasitata*
Juan Fernandez Petrel	*Pterodroma externa*
Hawaiian Petrel	*Pterodroma sandwichensis*
White-necked Petrel	*Pterodroma cervicalis*
Bonin Petrel	*Pterodroma hypoleuca*
Black-winged Petrel	*Pterodroma nigripennis*
Fea's Petrel	*Pterodroma feae*
Cook's Petrel	*Pterodroma cookii*
Stejneger's Petrel	*Pterodroma longirostris*
Phoenix Petrel	*Pterodroma alba*
Bulwer's Petrel	*Bulweria bulwerii*
Jouanin's Petrel	*Bulweria fallax*
Parkinson's Petrel	*Procellaria parkinsoni*
Streaked Shearwater	*Calonectris leucomelas*
Cory's Shearwater	*Calonectris diomedea*
Cape Verde Shearwater	*Calonectris edwardsii*
Pink-footed Shearwater	*Puffinus creatopus*

(*continued on next page*)

Seabirds (Continued)	Severity (Continued)
Individual	**2**
Common Name	**Scientific Name**
Flesh-footed Shearwater	*Puffinus carneipes*
Great Shearwater	*Puffinus gravis*
Wedge-tailed Shearwater	*Puffinus pacificus*
Buller's Shearwater	*Puffinus bulleri*
Sooty Shearwater	*Puffinus griseus*
Short-tailed Shearwater	*Puffinus tenuirostris*
Christmas Shearwater	*Puffinus nativitatis*
Manx Shearwater	*Puffinus puffinus*
Townsend's Shearwater	*Puffinus auricularis*
Bryan's Shearwater	*Puffinus bryani*
Black-vented Shearwater	*Puffinus opisthomelas*
Audubon's Shearwater	*Puffinus lherminieri*
Barolo Shearwater	*Puffinus baroli*
Wilson's Storm-Petrel	*Oceanites oceanicus*
White-faced Storm-Petrel	*Pelagodroma marina*
European Storm-Petrel	*Hydrobates pelagicus*
Fork-tailed Storm-Petrel	*Oceanodroma furcata*
Ringed Storm-Petrel	*Oceanodroma hornbyi*
Swinhoe's Storm-Petrel	*Oceanodroma monorhis*
Leach's Storm-Petrel	*Oceanodroma leucorhoa*
Ashy Storm-Petrel	*Oceanodroma homochroa*
Band-rumped Storm-Petrel	*Oceanodroma castro*
Wedge-rumped Storm-Petrel	*Oceanodroma tethys*
Black Storm-Petrel	*Oceanodroma melania*
Tristram's Storm-Petrel	*Oceanodroma tristrami*
Least Storm-Petrel	*Oceanodroma microsoma*
White-tailed Tropicbird	*Phaethon lepturus*
Red-billed Tropicbird	*Phaethon aethereus*
Red-tailed Tropicbird	*Phaethon rubricauda*
Magnificent Frigatebird	*Fregata magnificens*
Great Frigatebird	*Fregata minor*
Lesser Frigatebird	*Fregata ariel*
Masked Booby	*Sula dactylatra*
Nazca Booby	*Sula granti*
Blue-footed Booby	*Sula nebouxii*
Brown Booby	*Sula leucogaster*
Red-footed Booby	*Sula sula*

(*continued on next page*)

Seabirds (Continued)	Severity (Continued)
Individual	**2**
Common Name	**Scientific Name**
Northern Gannet	*Morus bassanus*
Great Skua	*Stercorarius skua*
South Polar Skua	*Stercorarius maccormicki*
Pomarine Jaeger	*Stercorarius pomarinus*
Parasitic Jaeger	*Stercorarius parasiticus*
Long-tailed Jaeger	*Stercorarius longicaudus*
Dovekie	*Alle alle*
Common Murre	*Uria aalge*
Thick-billed Murre	*Uria lomvia*
Razorbill	*Alca torda*
Great Auk	*Pinguinus impennis*
Black Guillemot	*Cepphus grylle*
Pigeon Guillemot	*Cepphus columba*
Long-billed Murrelet	*Brachyramphus perdix*
Marbled Murrelet	*Brachyramphus marmoratus*
Kittlitz's Murrelet	*Brachyramphus brevirostris*
Scripps's Murrelet	*Synthliboramphus scrippsi*
Guadalupe Murrelet	*Synthliboramphus hypoleucus*
Craveri's Murrelet	*Synthliboramphus craveri*
Ancient Murrelet	*Synthliboramphus antiquus*
Cassin's Auklet	*Ptychoramphus aleuticus*
Parakeet Auklet	*Aethia psittacula*
Least Auklet	*Aethia pusilla*
Whiskered Auklet	*Aethia pygmaea*
Crested Auklet	*Aethia cristatella*
Rhinoceros Auklet	*Cerorhinca monocerata*
Atlantic Puffin	*Fratercula arctica*
Horned Puffin	*Fratercula corniculata*
Tufted Puffin	*Fratercula cirrhata*
Pelicans/Cormorants	**Severity**
Individual	**4**
Common Name	**Scientific Name**
Brandt's Cormorant	*Phalacrocorax penicillatus*
Neotropic Cormorant	*Phalacrocorax brasilianus*
Double-crested Cormorant	*Phalacrocorax auritus*
Great Cormorant	*Phalacrocorax carbo*
Red-faced Cormorant	*Phalacrocorax urile*

(*continued on next page*)

Pelicans/Cormorants (Continued)	Severity (Continued)
Individual	**4**
Common Name	**Scientific Name**
Pelagic Cormorant	*Phalacrocorax pelagicus*
Anhinga	*Anhinga anhinga*
American White Pelican	*Pelecanus erythrorhynchos*
Brown Pelican	*Pelecanus occidentalis*
Waders	**Severity**
Individual	**2**
If Flocks ≥ 5	**5**
Common Name	**Scientific Name**
American Flamingo	*Phoenicopterus ruber*
Chilean Flamingo	*Phoenicopterus chilensis*
Jabiru	*Jabiru mycteria*
Wood Stork	*Mycteria Americana*
American Bittern	*Botaurus lentiginosus*
Great Bittern	*Botaurus stellaris*
Yellow Bittern	*Ixobrychus sinensis*
Least Bittern	*Ixobrychus exilis*
Bare-throated Tiger-Heron	*Tigrisoma mexicanum*
Great Blue Heron	*Ardea herodias*
Gray Heron	*Ardea cinerea*
Great Egret	*Ardea alba*
Intermediate Egret	*Mesophoyx intermedia*
Chinese Egret	*Egretta eulophotes*
Little Egret	*Egretta garzetta*
Western Reef-Heron	*Egretta gularis*
Snowy Egret	*Egretta thula*
Little Blue Heron	*Egretta caerulea*
Tricolored Heron	*Egretta tricolor*
Reddish Egret	*Egretta rufescens*
Cattle Egret	*Bubulcus ibis*
Chinese Pond-Heron	*Ardeola bacchus*
Green Heron	*Butorides virescens*
Striated Heron	*Butorides striata*
Black-crowned Night-Heron	*Nycticorax nycticorax*
Yellow-crowned Night-Heron	*Nyctanassa violacea*
White Ibis	*Eudocimus albus*
Scarlet Ibis	*Eudocimus ruber*
Glossy Ibis	*Plegadis falcinellus*

(*continued on next page*)

Waders (Continued)	Severity (Continued)
Individual	**2**
If Flocks ≥ 5	**5**
Common Name	**Scientific Name**
White-faced Ibis	*Plegadis chihi*
Sacred Ibis	*Threskiornis aethiopicus*
Roseate Spoonbill	*Platalea ajaja*
Limpkin	*Aramus guarauna*
Waterfowl	**Severity**
Individual	**3**
If Flocks < 5	**4**
If Flocks ≥ 5	**5**
Common Name	**Scientific Name**
Black-bellied Whistling-Duck	*Dendrocygna autumnalis*
West Indian Whistling-Duck	*Dendrocygna arborea*
Fulvous Whistling-Duck	*Dendrocygna bicolor*
Taiga Bean-Goose	*Anser fabalis*
Tundra Bean-Goose	*Anser serrirostris*
Pink-footed Goose	*Anser brachyrhynchus*
Greater White-fronted Goose	*Anser albifrons*
Lesser White-fronted Goose	*Anser erythropus*
Graylag Goose	*Anser anser*
Bar-headed Goose	*Anser indicus*
Emperor Goose	*Chen canagica*
Snow Goose	*Chen caerulescens*
Ross's Goose	*Chen rossii*
Brant	*Branta bernicla*
Barnacle Goose	*Branta leucopsis*
Cackling Goose	*Branta hutchinsii*
Canada Goose	*Branta canadensis*
Hawaiian Goose	*Branta sandvicensis*
Mute Swan	*Cygnus olor*
Trumpeter Swan	*Cygnus buccinator*
Tundra Swan	*Cygnus columbianus*
Whooper Swan	*Cygnus cygnus*
Orinoco Goose	*Neochen jubata*
Muscovy Duck	*Cairina moschata*
Wood Duck	*Aix sponsa*
Gadwall	*Anas strepera*
Falcated Duck	*Anas falcata*

(*continued on next page*)

Waterfowl (Continued)	**Severity (Continued)**
Individual	**3**
If Flocks < 5	**4**
If Flocks ≥ 5	**5**
Common Name	**Scientific Name**
Eurasian Wigeon	*Anas penelope*
American Wigeon	*Anas americana*
American Black Duck	*Anas rubripes*
Mallard	*Anas platyrhynchos*
Mottled Duck	*Anas fulvigula*
Hawaiian Duck	*Anas wyvilliana*
Laysan Duck	*Anas laysanensis*
Eastern Spot-billed Duck	*Anas zonorhyncha*
Blue-winged Teal	*Anas discors*
Cinnamon Teal	*Anas cyanoptera*
Northern Shoveler	*Anas clypeata*
White-cheeked Pintail	*Anas bahamensis*
Northern Pintail	*Anas acuta*
Garganey	*Anas querquedula*
Baikal Teal	*Anas formosa*
Green-winged Teal	*Anas crecca*
Canvasback	*Aythya valisineria*
Redhead	*Aythya americana*
Common Pochard	*Aythya ferina*
Ring-necked Duck	*Aythya collaris*
Tufted Duck	*Aythya fuligula*
Greater Scaup	*Aythya marila*
Lesser Scaup	*Aythya affinis*
Steller's Eider	*Polysticta stelleri*
Spectacled Eider	*Somateria fischeri*
King Eider	*Somateria spectabilis*
Common Eider	*Somateria mollissima*
Harlequin Duck	*Histrionicus histrionicus*
Labrador Duck	*Camptorhynchus labradorius*
Surf Scoter	*Melanitta perspicillata*
White-winged Scoter	*Melanitta fusca*
Common Scoter	*Melanitta nigra*
Black Scoter	*Melanitta americana*
Long-tailed Duck	*Clangula hyemalis*
Bufflehead	*Bucephala albeola*

(*continued on next page*)

Waterfowl (Continued)	Severity (Continued)
Individual	**3**
If Flocks < 5	**4**
If Flocks ≥ 5	**5**
Common Name	**Scientific Name**
Common Goldeneye	*Bucephala clangula*
Barrow's Goldeneye	*Bucephala islandica*
Smew	*Mergellus albellus*
Hooded Merganser	*Lophodytes cucullatus*
Common Merganser	*Mergus merganser*
Red-breasted Merganser	*Mergus serrator*
Masked Duck	*Nomonyx dominicus*
Ruddy Duck	*Oxyura jamaicensis*
Raptors/Vultures/Owls	**Severity**
Individual	**2**
Common Name	**Scientific Name**
Black Vulture	*Coragyps atratus*
Turkey Vulture	*Cathartes aura*
California Condor	*Gymnogyps californianus*
Osprey	*Pandion haliaetus*
Hook-billed Kite	*Chondrohierax uncinatus*
Swallow-tailed Kite	*Elanoides forficatus*
White-tailed Kite	*Elanus leucurus*
Snail Kite	*Rostrhamus sociabilis*
Double-toothed Kite	*Harpagus bidentatus*
Mississippi Kite	*Ictinia mississippiensis*
Black Kite	*Milvus migrans*
Bald Eagle	*Haliaeetus leucocephalus*
White-tailed Eagle	*Haliaeetus albicilla*
Steller's Sea-Eagle	*Haliaeetus pelagicus*
Northern Harrier	*Circus cyaneus*
Chinese Sparrowhawk	*Accipiter soloensis*
Sharp-shinned Hawk	*Accipiter striatus*
Cooper's Hawk	*Accipiter cooperii*
Northern Goshawk	*Accipiter gentilis*
Crane Hawk	*Geranospiza caerulescens*
Common Black Hawk	*Buteogallus anthracinus*
Great Black Hawk	*Buteogallus urubitinga*
Harris's Hawk	*Parabuteo unicinctus*
White-tailed Hawk	*Geranoaetus albicaudatus*

(*continued on next page*)

Raptors/Vultures/Owls (Continued)	Severity (Continued)
Individual	**2**
Common Name	**Scientific Name**
Roadside Hawk	*Buteo magnirostris*
Red-shouldered Hawk	*Buteo lineatus*
Broad-winged Hawk	*Buteo platypterus*
Gray Hawk	*Buteo plagiatus*
Gray-lined Hawk	*Buteo nitidus*
Short-tailed Hawk	*Buteo brachyurus*
Swainson's Hawk	*Buteo swainsoni*
Zone-tailed Hawk	*Buteo albonotatus*
Hawaiian Hawk	*Buteo solitarius*
Red-tailed Hawk	*Buteo jamaicensis*
Common Buzzard	*Buteo buteo*
Ferruginous Hawk	*Buteo regalis*
Rough-legged Hawk	*Buteo lagopus*
Golden Eagle	*Aquila chrysaetos*
Barn Owl	*Tyto alba*
Oriental Scops-Owl	*Otus sunia*
Flammulated Owl	*Psiloscops flammeolus*
Western Screech-Owl	*Megascops kennicottii*
Eastern Screech-Owl	*Megascops asio*
Whiskered Screech-Owl	*Megascops trichopsis*
Spectacled Owl	*Pulsatrix perspicillata*
Great Horned Owl	*Bubo virginianus*
Snowy Owl	*Bubo scandiacus*
Northern Hawk Owl	*Surnia ulula*
Northern Pygmy-Owl	*Glaucidium gnoma*
Ferruginous Pygmy-Owl	*Glaucidium brasilianum*
Elf Owl	*Micrathene whitneyi*
Burrowing Owl	*Athene cunicularia*
Mottled Owl	*Ciccaba virgata*
Spotted Owl	*Strix occidentalis*
Barred Owl	*Strix varia*
Great Gray Owl	*Strix nebulosa*
Long-eared Owl	*Asio otus*
Stygian Owl	*Asio stygius*
Short-eared Owl	*Asio flammeus*
Boreal Owl	*Aegolius funereus*
Northern Saw-whet Owl	*Aegolius acadicus*

(*continued on next page*)

Raptors/Vultures/Owls (Continued)	Severity (Continued)
Individual	**2**
Common Name	**Scientific Name**
Northern Boobook	*Ninox japonica*
Collared Forest-Falcon	*Micrastur semitorquatus*
Crested Caracara	*Caracara cheriway*
Eurasian Kestrel	*Falco tinnunculus*
American Kestrel	*Falco sparverius*
Red-footed Falcon	*Falco vespertinus*
Merlin	*Falco columbarius*
Eurasian Hobby	*Falco subbuteo*
Aplomado Falcon	*Falco femoralis*
Gyrfalcon	*Falco rusticolus*
Peregrine Falcon	*Falco peregrinus*
Prairie Falcon	*Falco mexicanus*
Upland Game Birds	**Severity Score**
Individual	**2**
Turkeys	**5**
Common Name	**Scientific Name**
Plain Chachalaca	*Ortalis vetula*
Helmeted Guineafowl	*Numida meleagris*
Mountain Quail	*Oreortyx pictus*
Scaled Quail	*Callipepla squamata*
California Quail	*Callipepla californica*
Gambel's Quail	*Callipepla gambelii*
Northern Bobwhite	*Colinus virginianus*
Montezuma Quail	*Cyrtonyx montezumae*
Himalayan Snowcock	*Tetraogallus himalayensis*
Chukar	*Alectoris chukar*
Gray Francolin	*Francolinus pondicerianus*
Black Francolin	*Francolinus francolinus*
Erckel's Francolin	*Francolinus erckelii*
Gray Partridge	*Perdix perdix*
Chinese Bamboo-Partridge	*Bambusicola thoracicus*
Red Junglefowl	*Gallus gallus*
Kalij Pheasant	*Lophura leucomelanos*
Silver Pheasant	*Lophura nycthemera*
Elliot's Pheasant	*Syrmaticus ellioti*
Ring-necked Pheasant	*Phasianus colchicus*
Lady Amherst's Pheasant	*Chrysolophus amherstiae*

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Upland Game Birds (Continued)	Severity Score (Continued)
Individual	**2**
Turkeys	**5**
Common Name	**Scientific Name**
Indian Peafowl	*Pavo cristatus*
Ruffed Grouse	*Bonasa umbellus*
Greater Sage-Grouse	*Centrocercus urophasianus*
Gunnison Sage-Grouse	*Centrocercus minimus*
Spruce Grouse	*Falcipennis canadensis*
Willow Ptarmigan	*Lagopus lagopus*
Rock Ptarmigan	*Lagopus muta*
White-tailed Ptarmigan	*Lagopus leucura*
Dusky Grouse	*Dendragapus obscurus*
Sooty Grouse	*Dendragapus fuliginosus*
Sharp-tailed Grouse	*Tympanuchus phasianellus*
Greater Prairie-Chicken	*Tympanuchus cupido*
Lesser Prairie-Chicken	*Tympanuchus pallidicinctus*
Wild Turkey	*Meleagris gallopavo*
Cranes	**Severity**
Individual	**5**
Common Name	**Scientific Name**
Gray Crowned Crane	*Balearica regulorum*
Sandhill Crane	*Grus canadensis*
Sarus Crane	*Grus antigone*
Common Crane	*Grus grus*
Hooded Crane	*Grus monacha*
Whooping Crane	*Grus americana*
Shorebirds	**Severity**
Individual	**1**
If Flocks < 20	**4**
If Flocks ≥ 20	**5**
Common Name	**Scientific Name**
Double-striped Thick-knee	*Burhinus bistriatus*
Black-winged Stilt	*Himantopus himantopus*
Black-necked Stilt	*Himantopus mexicanus*
American Avocet	*Recurvirostra americana*
Eurasian Oystercatcher	*Haematopus ostralegus*
American Oystercatcher	*Haematopus palliatus*
Black Oystercatcher	*Haematopus bachmani*
Northern Lapwing	*Vanellus vanellus*

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Shorebirds (Continued)	Severity (Continued)
Individual	**1**
If Flocks < 20	**4**
If Flocks ≥ 20	**5**
Common Name	**Scientific Name**
Sociable Lapwing	*Vanellus gregarious*
Black-bellied Plover	*Pluvialis squatarola*
European Golden-Plover	*Pluvialis apricaria*
American Golden-Plover	*Pluvialis dominica*
Pacific Golden-Plover	*Pluvialis fulva*
Lesser Sand-Plover	*Charadrius mongolus*
Greater Sand-Plover	*Charadrius leschenaultia*
Collared Plover	*Charadrius collaris*
Snowy Plover	*Charadrius nivosus*
Wilson's Plover	*Charadrius wilsonia*
Common Ringed Plover	*Charadrius hiaticula*
Semipalmated Plover	*Charadrius semipalmatus*
Piping Plover	*Charadrius melodus*
Little Ringed Plover	*Charadrius dubius*
Killdeer	*Charadrius vociferous*
Mountain Plover	*Charadrius montanus*
Eurasian Dotterel	*Charadrius morinellus*
Northern Jacana	*Jacana spinose*
Terek Sandpiper	*Xenus cinereus*
Common Sandpiper	*Actitis hypoleucos*
Spotted Sandpiper	*Actitis macularius*
Green Sandpiper	*Tringa ochropus*
Solitary Sandpiper	*Tringa solitaria*
Gray-tailed Tattler	*Tringa brevipes*
Wandering Tattler	*Tringa incana*
Spotted Redshank	*Tringa erythropus*
Greater Yellowlegs	*Tringa melanoleuca*
Common Greenshank	*Tringa nebularia*
Willet	*Tringa semipalmata*
Lesser Yellowlegs	*Tringa flavipes*
Marsh Sandpiper	*Tringa stagnatilis*
Wood Sandpiper	*Tringa glareola*
Common Redshank	*Tringa tetanus*
Upland Sandpiper	*Bartramia longicauda*
Little Curlew	*Numenius minutus*

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Shorebirds (Continued)	**Severity (Continued)**
Individual	**1**
If Flocks < 20	**4**
If Flocks ≥ 20	**5**
Common Name	**Scientific Name**
Eskimo Curlew	*Numenius borealis*
Whimbrel	*Numenius phaeopus*
Bristle-thighed Curlew	*Numenius tahitiensis*
Far Eastern Curlew	*Numenius madagascariensis*
Slender-billed Curlew	*Numenius tenuirostris*
Eurasian Curlew	*Numenius arquata*
Long-billed Curlew	*Numenius americanus*
Black-tailed Godwit	*Limosa limosa*
Hudsonian Godwit	*Limosa haemastica*
Bar-tailed Godwit	*Limosa lapponica*
Marbled Godwit	*Limosa fedoa*
Ruddy Turnstone	*Arenaria interpres*
Black Turnstone	*Arenaria melanocephala*
Great Knot	*Calidris tenuirostris*
Red Knot	*Calidris canutus*
Surfbird	*Calidris virgate*
Ruff	*Calidris pugnax*
Broad-billed Sandpiper	*Calidris falcinellus*
Sharp-tailed Sandpiper	*Calidris acuminate*
Stilt Sandpiper	*Calidris himantopus*
Curlew Sandpiper	*Calidris ferruginea*
Temminck's Stint	*Calidris temminckii*
Long-toed Stint	*Calidris subminuta*
Spoon-billed Sandpiper	*Calidris pygmea*
Red-necked Stint	*Calidris ruficollis*
Sanderling	*Calidris alba*
Dunlin	*Calidris alpine*
Rock Sandpiper	*Calidris ptilocnemis*
Purple Sandpiper	*Calidris maritima*
Baird's Sandpiper	*Calidris bairdii*
Little Stint	*Calidris minuta*
Least Sandpiper	*Calidris minutilla*
White-rumped Sandpiper	*Calidris fuscicollis*
Buff-breasted Sandpiper	*Calidris subruficollis*
Pectoral Sandpiper	*Calidris melanotos*

(*continued on next page*)

Shorebirds (Continued)	**Severity (Continued)**
Individual	**1**
If Flocks < 20	**4**
If Flocks ≥ 20	**5**
Common Name	**Scientific Name**
Semipalmated Sandpiper	*Calidris pusilla*
Western Sandpiper	*Calidris mauri*
Short-billed Dowitcher	*Limnodromus griseus*
Long-billed Dowitcher	*Limnodromus scolopaceus*
Jack Snipe	*Lymnocryptes minimus*
Wilson's Snipe	*Gallinago delicate*
Common Snipe	*Gallinago gallinago*
Pin-tailed Snipe	*Gallinago stenura*
Solitary Snipe	*Gallinago solitaria*
Eurasian Woodcock	*Scolopax rusticola*
American Woodcock	*Scolopax minor*
Wilson's Phalarope	*Phalaropus tricolor*
Red-necked Phalarope	*Phalaropus lobatus*
Red Phalarope	*Phalaropus fulicarius*
Oriental Pratincole	*Glareola maldivarum*
Gulls/Terns	**Severity**
Individual	**2**
If Flocks < 10	**4**
If Flocks ≥ 10	**5**
Common Name	**Scientific Name**
Swallow-tailed Gull	*Creagrus furcatus*
Black-legged Kittiwake	*Rissa tridactyla*
Red-legged Kittiwake	*Rissa brevirostris*
Ivory Gull	*Pagophila eburnea*
Sabine's Gull	*Xema sabini*
Bonaparte's Gull	*Chroicocephalus philadelphia*
Black-headed Gull	*Chroicocephalus ridibundus*
Little Gull	*Hydrocoloeus minutus*
Ross's Gull	*Rhodostethia rosea*
Laughing Gull	*Leucophaeus atricilla*
Franklin's Gull	*Leucophaeus pipixcan*
Belcher's Gull	*Larus belcheri*
Black-tailed Gull	*Larus crassirostris*
Heermann's Gull	*Larus heermanni*
Mew Gull	*Larus canus*

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Gulls/Terns (Continued)	Severity (Continued)
Individual	**2**
If Flocks < 10	**4**
If Flocks ≥ 10	**5**
Common Name	**Scientific Name**
Ring-billed Gull	*Larus delawarensis*
Western Gull	*Larus occidentalis*
Yellow-footed Gull	*Larus livens*
California Gull	*Larus californicus*
Herring Gull	*Larus argentatus*
Yellow-legged Gull	*Larus michahellis*
Thayer's Gull	*Larus thayeri*
Iceland Gull	*Larus glaucoides*
Lesser Black-backed Gull	*Larus fuscus*
Slaty-backed Gull	*Larus schistisagus*
Glaucous-winged Gull	*Larus glaucescens*
Glaucous Gull	*Larus hyperboreus*
Great Black-backed Gull	*Larus marinus*
Kelp Gull	*Larus dominicanus*
Brown Noddy	*Anous stolidus*
Black Noddy	*Anous minutus*
Blue-gray Noddy	*Procelsterna cerulea*
White Tern	*Gygis alba*
Sooty Tern	*Onychoprion fuscatus*
Gray-backed Tern	*Onychoprion lunatus*
Bridled Tern	*Onychoprion anaethetus*
Aleutian Tern	*Onychoprion aleuticus*
Little Tern	*Sternula albifrons*
Least Tern	*Sternula antillarum*
Large-billed Tern	*Phaetusa simplex*
Gull-billed Tern	*Gelochelidon nilotica*
Caspian Tern	*Hydroprogne caspia*
Black Tern	*Chlidonias niger*
White-winged Tern	*Chlidonias leucopterus*
Whiskered Tern	*Chlidonias hybrida*
Roseate Tern	*Sterna dougallii*
Common Tern	*Sterna hirundo*
Arctic Tern	*Sterna paradisaea*
Forster's Tern	*Sterna forsteri*
Royal Tern	*Thalasseus maximus*

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Gulls/Terns (Continued)	Severity (Continued)
Individual	**2**
If Flocks < 10	**4**
If Flocks ≥ 10	**5**
Common Name	**Scientific Name**
Great Crested Tern	*Thalasseus bergii*
Sandwich Tern	*Thalasseus sandvicensis*
Elegant Tern	*Thalasseus elegans*
Black Skimmer	*Rynchops niger*
Pigeons/Doves	**Severity**
Individual	**1**
If Flocks < 20	**4**
If Flocks ≥ 20	**5**
Common Name	**Scientific Name**
Chestnut-bellied Sandgrouse	*Pterocles exustus*
Rock Pigeon	*Columba livia*
Scaly-naped Pigeon	*Patagioenas squamosa*
White-crowned Pigeon	*Patagioenas leucocephala*
Red-billed Pigeon	*Patagioenas flavirostris*
Band-tailed Pigeon	*Patagioenas fasciata*
Oriental Turtle-Dove	*Streptopelia orientalis*
African Collared-Dove	*Streptopelia roseogrisea*
European Turtle-Dove	*Streptopelia turtur*
Eurasian Collared-Dove	*Streptopelia decaocto*
Spotted Dove	*Streptopelia chinensis*
Laughing Dove	*Streptopelia senegalensis*
Zebra Dove	*Geopelia striata*
Inca Dove	*Columbina inca*
Common Ground-Dove	*Columbina passerina*
Ruddy Ground-Dove	*Columbina talpacoti*
Ruddy Quail-Dove	*Geotrygon montana*
Key West Quail-Dove	*Geotrygon chrysia*
White-tipped Dove	*Leptotila verreauxi*
White-winged Dove	*Zenaida asiatica*
Zenaida Dove	*Zenaida aurita*
Mourning Dove	*Zenaida macroura*

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Parrots	**Severity**
Individual	**1**
Common Name	**Scientific Name**
Galah	*Eolophus roseicapilla*
Tanimbar Corella	*Cacatua goffiniana*
Sulphur-crested Cockatoo	*Cacatua galerita*
Salmon-crested Cockatoo	*Cacutua moluccensis*
Eclectus Parrot	*Eclectus roratus*
Alexandrine Parakeet	*Psittacula eupatria*
Rose-ringed Parakeet	*Psittacula krameri*
Plum-headed Parakeet	*Psittacula cyanocephala*
Blossom-headed Parakeet	*Psittacula roseata*
Pale-headed Rosella	*Platycercus adscitus*
Budgerigar	*Melopsittacus undulatus*
Chattering Lory	*Lorius garrulus*
Rainbow Lorikeet	*Trichoglossus haematodus*
Scaly-breasted Lorikeet	*Trichoglossus chlorolepidotus*
Rosy-faced Lovebird	*Agapornis roseicollis*
Fischer's Lovebird	*Agapornis fischeri*
Yellow-collared Lovebird	*Agapornis personatus*
Gray Parrot	*Psittacus erithacus*
Rueppell's Parrot	*Poicephalus rueppellii*
Senegal Parrot	*Poicephalus senegalus*
Monk Parakeet	*Myiopsitta monachus*
Tui Parakeet	*Brotogeris sanctithomae*
White-winged Parakeet	*Brotogeris versicolurus*
Yellow-chevroned Parakeet	*Brotogeris chiriri*
Orange-chinned Parakeet	*Brotogeris jugularis*
White-crowned Parrot	*Pionus senilis*
Festive Parrot	*Amazona festiva*
Red-spectacled Parrot	*Amazona pretrei*
Red-crowned Parrot	*Amazona viridigenalis*
Lilac-crowned Parrot	*Amazona finschi*
Red-lored Parrot	*Amazona autumnalis*
Yellow-headed Parrot	*Amazona oratrix*
Yellow-shouldered Parrot	*Amazona barbadensis*
Turquoise-fronted Parrot	*Amazona aestiva*
White-fronted Parrot	*Amazona albifrons*
Hispaniolan Parrot	*Amazona ventralis*
Mealy Parrot	*Amazona farinosa*

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Parrots (Continued)	Severity (Continued)
Individual	**1**
Common Name	**Scientific Name**
Orange-winged parrot	*Amazona amazonica*
Maroon-bellied Parakeet	*Pyrrhura frontalis*
Green-cheeked Parakeet	*Pyrrhura molinae*
Burrowing Parakeet	*Cyanoliseus patagonus*
Hyacinth Macaw	*Anodorhynchus hyacinthinus*
Thick-billed Parrot	*Rhynchopsitta pachyrhyncha*
Maroon-fronted Parrot	*Rhynchopsitta terrisi*
Orange-fronted Parakeet	*Eupsittula canicularis*
Peach-fronted Parakeet	*Eupsittula aurea*
Brown-throated Parakeet	*Eupsittula pertinax*
Dusky-headed Parakeet	*Aratinga weddellii*
Nanday Parakeet	*Aratinga nenday*
Yellow-collared Macaw	*Primolius auricollis*
Blue-and-yellow Macaw	*Ara ararauna*
Military Macaw	*Ara militaris*
Scarlet Macaw	*Ara macao*
Chestnut-fronted Macaw	*Ara severus*
Blue-crowned Parakeet	*Thectocercus acuticaudatus*
Red-shouldered Macaw	*Diopsittaca nobilis*
Crimson-fronted Parakeet	*Psittacara finschi*
Scarlet-fronted Parakeet	*Psittacara wagleri*
Mitred Parakeet	*Psittacara mitratus*
Red-masked Parakeet	*Psittacara erythrogenys*
White-eyed Parakeet	*Psittacara leucophthalmus*
Aerial Foragers	**Severity**
Individual	**1**
Common Name	**Scientific Name**
Lesser Nighthawk	*Chordeiles acutipennis*
Common Nighthawk	*Chordeiles minor*
Antillean Nighthawk	*Chordeiles gundlachii*
Common Pauraque	*Nyctidromus albicollis*
Common Poorwill	*Phalaenoptilus nuttallii*
Chuck-will's-widow	*Antrostomus carolinensis*
Buff-collared Nightjar	*Antrostomus ridgwayi*
Eastern Whip-poor-will	*Antrostomus vociferus*
Mexican Whip-poor-will	*Antrostomus arizonae*
Gray Nightjar	*Caprimulgus jotaka*

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Aerial Foragers (Continued)	Severity (Continued)
Individual	**1**
Common Name	**Scientific Name**
Black Swift	*Cypseloides niger*
White-collared Swift	*Streptoprocne zonaris*
Chimney Swift	*Chaetura pelagica*
Vaux's Swift	*Chaetura vauxi*
White-throated Needletail	*Hirundapus caudacutus*
Mariana Swiftlet	*Aerodramus bartschi*
White-nest Swiftlet	*Aerodramus fuciphagus*
Common Swift	*Apus apus*
Pacific Swift	*Apus pacificus*
White-throated Swift	*Aeronautes saxatalis*
Antillean Palm-Swift	*Tachornis phoenicobia*
Purple Martin	*Progne subis*
Cuban Martin	*Progne cryptoleuca*
Gray-breasted Martin	*Progne chalybea*
Southern Martin	*Progne elegans*
Brown-chested Martin	*Progne tapera*
Tree Swallow	*Tachycineta bicolor*
Mangrove Swallow	*Tachycineta albilinea*
Violet-green Swallow	*Tachycineta thalassina*
Bahama Swallow	*Tachycineta cyaneoviridis*
Northern Rough-winged Swallow	*Stelgidopteryx serripennis*
Bank Swallow	*Riparia riparia*
Cliff Swallow	*Petrochelidon pyrrhonota*
Cave Swallow	*Petrochelidon fulva*
Barn Swallow	*Hirundo rustica*
Common House-Martin	*Delichon urbicum*
Woodland Birds	**Severity**
Individual	**1**
Common Name	**Scientific Name**
Common Cuckoo	*Cuculus canorus*
Oriental Cuckoo	*Cuculus optatus*
Dark-billed Cuckoo	*Coccyzus melacoryphus*
Yellow-billed Cuckoo	*Coccyzus americanus*
Mangrove Cuckoo	*Coccyzus minor*
Black-billed Cuckoo	*Coccyzus erythropthalmus*
Smooth-billed Ani	*Crotophaga ani*
Groove-billed Ani	*Crotophaga sulcirostris*

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Woodland Birds (Continued)	Severity (Continued)
Individual	**1**
Common Name	**Scientific Name**
Green Violetear	*Colibri thalassinus*
Green-breasted Mango	*Anthracothorax prevostii*
Magnificent Hummingbird	*Eugenes fulgens*
Plain-capped Starthroat	*Heliomaster constantii*
Blue-throated Hummingbird	*Lampornis clemenciae*
Bahama Woodstar	*Calliphlox evelynae*
Lucifer Hummingbird	*Calothorax lucifer*
Ruby-throated Hummingbird	*Archilochus colubris*
Black-chinned Hummingbird	*Archilochus alexandri*
Anna's Hummingbird	*Calypte anna*
Costa's Hummingbird	*Calypte costae*
Bumblebee Hummingbird	*Atthis heloisa*
Broad-tailed Hummingbird	*Selasphorus platycercus*
Rufous Hummingbird	*Selasphorus rufus*
Allen's Hummingbird	*Selasphorus sasin*
Calliope Hummingbird	*Selasphorus calliope*
Broad-billed Hummingbird	*Cynanthus latirostris*
Berylline Hummingbird	*Amazilia beryllina*
Buff-bellied Hummingbird	*Amazilia yucatanensis*
Cinnamon Hummingbird	*Amazilia rutila*
Violet-crowned Hummingbird	*Amazilia violiceps*
White-eared Hummingbird	*Hylocharis leucotis*
Xantus's Hummingbird	*Hylocharis xantusii*
Eared Quetzal	*Euptilotis neoxenus*
Elegant Trogon	*Trogon elegans*
Eurasian Hoopoe	*Upupa epops*
Eurasian Wryneck	*Jynx torquilla*
Lewis's Woodpecker	*Melanerpes lewis*
Red-headed Woodpecker	*Melanerpes erythrocephalus*
Acorn Woodpecker	*Melanerpes formicivorus*
Gila Woodpecker	*Melanerpes uropygialis*
Golden-fronted Woodpecker	*Melanerpes aurifrons*
Red-bellied Woodpecker	*Melanerpes carolinus*
Williamson's Sapsucker	*Sphyrapicus thyroideus*
Yellow-bellied Sapsucker	*Sphyrapicus varius*
Red-naped Sapsucker	*Sphyrapicus nuchalis*
Red-breasted Sapsucker	*Sphyrapicus ruber*

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Woodland Birds (Continued)	Severity (Continued)
Individual	**1**
Common Name	**Scientific Name**
Great Spotted Woodpecker	*Dendrocopos major*
Ladder-backed Woodpecker	*Picoides scalaris*
Nuttall's Woodpecker	*Picoides nuttallii*
Downy Woodpecker	*Picoides pubescens*
Hairy Woodpecker	*Picoides villosus*
Arizona Woodpecker	*Picoides arizonae*
Red-cockaded Woodpecker	*Picoides borealis*
White-headed Woodpecker	*Picoides albolarvatus*
American Three-toed Woodpecker	*Picoides dorsalis*
Black-backed Woodpecker	*Picoides arcticus*
Northern Flicker	*Colaptes auratus*
Gilded Flicker	*Colaptes chrysoides*
Pileated Woodpecker	*Dryocopus pileatus*
Ivory-billed Woodpecker	*Campephilus principalis*
Barred Antshrike	*Thamnophilus doliatus*
Northern Beardless-Tyrannulet	*Camptostoma imberbe*
Greenish Elaenia	*Myiopagis viridicata*
Caribbean Elaenia	*Elaenia martinica*
White-crested Elaenia	*Elaenia albiceps*
Tufted Flycatcher	*Mitrephanes phaeocercus*
Olive-sided Flycatcher	*Contopus cooperi*
Greater Pewee	*Contopus pertinax*
Western Wood-Pewee	*Contopus sordidulus*
Eastern Wood-Pewee	*Contopus virens*
Cuban Pewee	*Contopus caribaeus*
Yellow-bellied Flycatcher	*Empidonax flaviventris*
Acadian Flycatcher	*Empidonax virescens*
Alder Flycatcher	*Empidonax alnorum*
Willow Flycatcher	*Empidonax traillii*
Least Flycatcher	*Empidonax minimus*
Hammond's Flycatcher	*Empidonax hammondii*
Gray Flycatcher	*Empidonax wrightii*
Dusky Flycatcher	*Empidonax oberholseri*
Pacific-slope Flycatcher	*Empidonax difficilis*
Cordilleran Flycatcher	*Empidonax occidentalis*
Buff-breasted Flycatcher	*Empidonax fulvifrons*
Black Phoebe	*Sayornis nigricans*

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Woodland Birds (Continued)	Severity (Continued)
Individual	**1**
Common Name	**Scientific Name**
Eastern Phoebe	*Sayornis phoebe*
Say's Phoebe	*Sayornis saya*
Vermilion Flycatcher	*Pyrocephalus rubinus*
Dusky-capped Flycatcher	*Myiarchus tuberculifer*
Ash-throated Flycatcher	*Myiarchus cinerascens*
Nutting's Flycatcher	*Myiarchus nuttingi*
Great Crested Flycatcher	*Myiarchus crinitus*
Brown-crested Flycatcher	*Myiarchus tyrannulus*
La Sagra's Flycatcher	*Myiarchus sagrae*
Great Kiskadee	*Pitangus sulphuratus*
Social Flycatcher	*Myiozetetes similis*
Sulphur-bellied Flycatcher	*Myiodynastes luteiventris*
Piratic Flycatcher	*Legatus leucophaius*
Variegated Flycatcher	*Empidonomus varius*
Crowned Slaty Flycatcher	*Empidonomus aurantioatrocristatus*
Tropical Kingbird	*Tyrannus melancholicus*
Couch's Kingbird	*Tyrannus couchii*
Cassin's Kingbird	*Tyrannus vociferans*
Thick-billed Kingbird	*Tyrannus crassirostris*
Western Kingbird	*Tyrannus verticalis*
Eastern Kingbird	*Tyrannus tyrannus*
Gray Kingbird	*Tyrannus dominicensis*
Loggerhead Kingbird	*Tyrannus caudifasciatus*
Fork-tailed Flycatcher	*Tyrannus savana*
Masked Tityra	*Tityra semifasciata*
Gray-collared Becard	*Pachyramphus major*
Rose-throated Becard	*Pachyramphus aglaiae*
Brown Shrike	*Lanius cristatus*
Loggerhead Shrike	*Lanius ludovicianus*
Northern Shrike	*Lanius excubitor*
White-eyed Vireo	*Vireo griseus*
Thick-billed Vireo	*Vireo crassirostris*
Bell's Vireo	*Vireo bellii*
Black-capped Vireo	*Vireo atricapilla*
Gray Vireo	*Vireo vicinior*
Yellow-throated Vireo	*Vireo flavifrons*
Plumbeous Vireo	*Vireo plumbeus*

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Woodland Birds (Continued)	**Severity (Continued)**
Individual	**1**
Common Name	**Scientific Name**
Cassin's Vireo	*Vireo cassinii*
Blue-headed Vireo	*Vireo solitarius*
Hutton's Vireo	*Vireo huttoni*
Warbling Vireo	*Vireo gilvus*
Philadelphia Vireo	*Vireo philadelphicus*
Red-eyed Vireo	*Vireo olivaceus*
Yellow-green Vireo	*Vireo flavoviridis*
Black-whiskered Vireo	*Vireo altiloquus*
Yucatan Vireo	*Vireo magister*
Hawaii Elepaio	*Chasiempis sandwichensis*
Kauai Elepaio	*Chasiempis sclateri*
Oahu Elepaio	*Chasiempis ibidis*
Carolina Chickadee	*Poecile carolinensis*
Black-capped Chickadee	*Poecile atricapillus*
Mountain Chickadee	*Poecile gambeli*
Mexican Chickadee	*Poecile sclateri*
Chestnut-backed Chickadee	*Poecile rufescens*
Boreal Chickadee	*Poecile hudsonicus*
Gray-headed Chickadee	*Poecile cinctus*
Japanese Tit	*Parus minor*
Bridled Titmouse	*Baeolophus wollweberi*
Oak Titmouse	*Baeolophus inornatus*
Juniper Titmouse	*Baeolophus ridgwayi*
Tufted Titmouse	*Baeolophus bicolor*
Black-crested Titmouse	*Baeolophus atricristatus*
Verdin	*Auriparus flaviceps*
Bushtit	*Psaltriparus minimus*
Red-breasted Nuthatch	*Sitta canadensis*
White-breasted Nuthatch	*Sitta carolinensis*
Pygmy Nuthatch	*Sitta pygmaea*
Brown-headed Nuthatch	*Sitta pusilla*
Brown Creeper	*Certhia americana*
Rock Wren	*Salpinctes obsoletus*
Canyon Wren	*Catherpes mexicanus*
Eurasian Wren	*Troglodytes troglodytes*
House Wren	*Troglodytes aedon*
Pacific Wren	*Troglodytes pacificus*

(*continued on next page*)

Woodland Birds (Continued)	Severity (Continued)
Individual	**1**
Common Name	**Scientific Name**
Winter Wren	*Troglodytes hiemalis*
Sedge Wren	*Cistothorus platensis*
Marsh Wren	*Cistothorus palustris*
Carolina Wren	*Thryothorus ludovicianus*
Bewick's Wren	*Thryomanes bewickii*
Cactus Wren	*Campylorhynchus brunneicapillus*
Sinaloa Wren	*Thryophilus sinaloa*
Blue-gray Gnatcatcher	*Polioptila caerulea*
California Gnatcatcher	*Polioptila californica*
Black-tailed Gnatcatcher	*Polioptila melanura*
Black-capped Gnatcatcher	*Polioptila nigriceps*
Red-vented Bulbul	*Pycnonotus cafer*
Red-whiskered Bulbul	*Pycnonotus jocosus*
Golden-crowned Kinglet	*Regulus satrapa*
Ruby-crowned Kinglet	*Regulus calendula*
Japanese Bush-Warbler	*Cettia diphone*
Willow Warbler	*Phylloscopus trochilus*
Common Chiffchaff	*Phylloscopus collybita*
Wood Warbler	*Phylloscopus sibilatrix*
Dusky Warbler	*Phylloscopus fuscatus*
Pallas's Leaf Warbler	*Phylloscopus proregulus*
Yellow-browed Warbler	*Phylloscopus inornatus*
Arctic Warbler	*Phylloscopus borealis*
Kamchatka Leaf Warbler	*Phylloscopus examinandus*
Lesser Whitethroat	*Sylvia curruca*
Wrentit	*Chamaea fasciata*
Japanese White-eye	*Zosterops japonicus*
Chinese Hwamei	*Garrulax canorus*
Gray-sided Laughingthrush	*Lanthocincla caerulata*
Red-billed Leiothrix	*Leiothrix lutea*
Millerbird	*Acrocephalus familiaris*
Sedge Warbler	*Acrocephalus schoenobaenus*
Middendorff's Grasshopper-Warbler	*Locustella ochotensis*
Lanceolated Warbler	*Locustella lanceolata*
Gray-streaked Flycatcher	*Muscicapa griseisticta*
Asian Brown Flycatcher	*Muscicapa latirostris*
Spotted Flycatcher	*Muscicapa striata*

(*continued on next page*)

Woodland Birds (Continued)	**Severity (Continued)**
Individual	**1**
Common Name	**Scientific Name**
Dark-sided Flycatcher	*Muscicapa sibirica*
White-rumped Shama	*Copsychus malabaricus*
Rufous-tailed Robin	*Larvivora sibilans*
Siberian Blue Robin	*Lavivora cyane*
Bluethroat	*Luscinia svecica*
Siberian Rubythroat	*Calliope calliope*
Red-flanked Bluetail	*Tarsiger cyanurus*
Taiga Flycatcher	*Ficedula albicilla*
Narcissus Flycatcher	*Ficedula narcissina*
Mugimaki Flycatcher	*Ficedula mugimaki*
Common Redstart	*Phoenicurus phoenicurus*
Blue Rock-Thrush	*Monticola solitarius*
Siberian Stonechat	*Saxicola maurus*
Northern Wheatear	*Oenanthe oenanthe*
Eastern Bluebird	*Sialia sialis*
Western Bluebird	*Sialia mexicana*
Mountain Bluebird	*Sialia currucoides*
Townsend's Solitaire	*Myadestes townsendi*
Olomao	*Myadestes lanaiensis*
Omao	*Myadestes obscurus*
Puaiohi	*Myadestes palmeri*
Orange-billed Nightingale-Thrush	*Catharus aurantiirostris*
Black-headed Nightingale-Thrush	*Catharus mexicanus*
Veery	*Catharus fuscescens*
Gray-cheeked Thrush	*Catharus minimus*
Bicknell's Thrush	*Catharus bicknelli*
Swainson's Thrush	*Catharus ustulatus*
Hermit Thrush	*Catharus guttatus*
Wood Thrush	*Hylocichla mustelina*
Eurasian Blackbird	*Turdus merula*
Eyebrowed Thrush	*Turdus obscurus*
Dusky Thrush	*Turdus eunomus*
Fieldfare	*Turdus pilaris*
Redwing	*Turdus iliacus*
Song Thrush	*Turdus philomelos*
Clay-colored Thrush	*Turdus grayi*
White-throated Thrush	*Turdus assimilis*

(*continued on next page*)

Woodland Birds (Continued)	Severity (Continued)
Individual	**1**
Common Name	**Scientific Name**
Rufous-backed Robin	*Turdus rufopalliatus*
American Robin	*Turdus migratorius*
Varied Thrush	*Ixoreus naevius*
Aztec Thrush	*Ridgwayia pinicola*
Blue Mockingbird	*Melanotis caerulescens*
Black Catbird	*Melanoptila glabrirostris*
Gray Catbird	*Dumetella carolinensis*
Curve-billed Thrasher	*Toxostoma curvirostre*
Brown Thrasher	*Toxostoma rufum*
Long-billed Thrasher	*Toxostoma longirostre*
Bendire's Thrasher	*Toxostoma bendirei*
California Thrasher	*Toxostoma redivivum*
Le Conte's Thrasher	*Toxostoma lecontei*
Crissal Thrasher	*Toxostoma crissale*
Sage Thrasher	*Oreoscoptes montanus*
Bahama Mockingbird	*Mimus gundlachii*
Tropical Mockingbird	*Mimus gilvus*
Northern Mockingbird	*Mimus polyglottos*
Siberian Accentor	*Prunella montanella*
Western Yellow Wagtail	*Motacilla flava*
Eastern Yellow Wagtail	*Motacilla tschutschensis*
Citrine Wagtail	*Motacilla citreola*
Gray Wagtail	*Motacilla cinerea*
White Wagtail	*Motacilla alba*
Tree Pipit	*Anthus trivialis*
Bohemian Waxwing	*Bombycilla garrulus*
Cedar Waxwing	*Bombycilla cedrorum*
Gray Silky-flycatcher	*Ptiliogonys cinereus*
Phainopepla	*Phainopepla nitens*
Olive Warbler	*Peucedramus taeniatus*
Ovenbird	*Seiurus aurocapilla*
Worm-eating Warbler	*Helmitheros vermivorum*
Louisiana Waterthrush	*Parkesia motacilla*
Northern Waterthrush	*Parkesia noveboracensis*
Bachman's Warbler	*Vermivora bachmanii*
Golden-winged Warbler	*Vermivora chrysoptera*
Blue-winged Warbler	*Vermivora cyanoptera*

(*continued on next page*)

Woodland Birds (Continued)	Severity (Continued)
Individual	**1**
Common Name	**Scientific Name**
Black-and-white Warbler	*Mniotilta varia*
Prothonotary Warbler	*Protonotaria citrea*
Swainson's Warbler	*Limnothlypis swainsonii*
Crescent-chested Warbler	*Oreothlypis superciliosa*
Tennessee Warbler	*Oreothlypis peregrina*
Orange-crowned Warbler	*Oreothlypis celata*
Colima Warbler	*Oreothlypis crissalis*
Lucy's Warbler	*Oreothlypis luciae*
Nashville Warbler	*Oreothlypis ruficapilla*
Virginia's Warbler	*Oreothlypis virginiae*
Connecticut Warbler	*Oporornis agilis*
Gray-crowned Yellowthroat	*Geothlypis poliocephala*
MacGillivray's Warbler	*Geothlypis tolmiei*
Mourning Warbler	*Geothlypis philadelphia*
Kentucky Warbler	*Geothlypis formosa*
Common Yellowthroat	*Geothlypis trichas*
Hooded Warbler	*Setophaga citrina*
American Redstart	*Setophaga ruticilla*
Kirtland's Warbler	*Setophaga kirtlandii*
Cape May Warbler	*Setophaga tigrina*
Cerulean Warbler	*Setophaga cerulea*
Northern Parula	*Setophaga americana*
Tropical Parula	*Setophaga pitiayumi*
Magnolia Warbler	*Setophaga magnolia*
Bay-breasted Warbler	*Setophaga castanea*
Blackburnian Warbler	*Setophaga fusca*
Yellow Warbler	*Setophaga petechia*
Chestnut-sided Warbler	*Setophaga pensylvanica*
Blackpoll Warbler	*Setophaga striata*
Black-throated Blue Warbler	*Setophaga caerulescens*
Palm Warbler	*Setophaga palmarum*
Pine Warbler	*Setophaga pinus*
Yellow-rumped Warbler	*Setophaga coronata*
Yellow-throated Warbler	*Setophaga dominica*
Prairie Warbler	*Setophaga discolor*
Grace's Warbler	*Setophaga graciae*
Black-throated Gray Warbler	*Setophaga nigrescens*

(*continued on next page*)

Woodland Birds (Continued)	Severity (Continued)
Individual	**1**
Common Name	**Scientific Name**
Townsend's Warbler	*Setophaga townsendi*
Hermit Warbler	*Setophaga occidentalis*
Golden-cheeked Warbler	*Setophaga chrysoparia*
Black-throated Green Warbler	*Setophaga virens*
Fan-tailed Warbler	*Basileuterus lachrymosus*
Rufous-capped Warbler	*Basileuterus rufifrons*
Golden-crowned Warbler	*Basileuterus culicivorus*
Canada Warbler	*Cardellina canadensis*
Wilson's Warbler	*Cardellina pusilla*
Red-faced Warbler	*Cardellina rubrifrons*
Painted Redstart	*Myioborus pictus*
Slate-throated Redstart	*Myioborus miniatus*
Yellow-breasted Chat	*Icteria virens*
Bananaquit	*Coereba flaveola*
Red-crested Cardinal	*Paroaria coronata*
Yellow-billed Cardinal	*Paroaria capitata*
Crimson-collared Tanager	*Ramphocelus sanguinolentus*
Saffron Finch	*Sicalis flaveola*
White-collared Seedeater	*Sporophila torqueola*
Yellow-faced Grassquit	*Tiaris olivaceus*
Black-faced Grassquit	*Tiaris bicolor*
Greater Antillean Bullfinch	*Loxigilla violacea*
Western Spindalis	*Spindalis zena*
Olive Sparrow	*Arremonops rufivirgatus*
Green-tailed Towhee	*Pipilo chlorurus*
Spotted Towhee	*Pipilo maculatus*
Eastern Towhee	*Pipilo erythrophthalmus*
Rufous-crowned Sparrow	*Aimophila ruficeps*
Canyon Towhee	*Melozone fusca*
California Towhee	*Melozone crissalis*
Abert's Towhee	*Melozone aberti*
Rufous-winged Sparrow	*Peucaea carpalis*
Striped Sparrow	*Oriturus superciliosus*
American Tree Sparrow	*Spizella arborea*
Chipping Sparrow	*Spizella passerina*
Black-chinned Sparrow	*Spizella atrogularis*
Five-striped Sparrow	*Amphispiza quinquestriata*

(*continued on next page*)

Woodland Birds (Continued)	**Severity (Continued)**
Individual	**1**
Common Name	**Scientific Name**
Black-throated Sparrow	*Amphispiza bilineata*
Sagebrush Sparrow	*Artemisiospiza nevadensis*
Bell's Sparrow	*Artemisiospiza belli*
Nelson's Sparrow	*Ammodramus nelsoni*
Saltmarsh Sparrow	*Ammodramus caudacutus*
Seaside Sparrow	*Ammodramus maritimus*
Fox Sparrow	*Passerella iliaca*
Song Sparrow	*Melospiza melodia*
Lincoln's Sparrow	*Melospiza lincolnii*
Swamp Sparrow	*Melospiza georgiana*
White-throated Sparrow	*Zonotrichia albicollis*
Harris's Sparrow	*Zonotrichia querula*
White-crowned Sparrow	*Zonotrichia leucophrys*
Golden-crowned Sparrow	*Zonotrichia atricapilla*
Dark-eyed Junco	*Junco hyemalis*
Yellow-eyed Junco	*Junco phaeonotus*
Pine Bunting	*Emberiza leucocephalos*
Yellow-browed Bunting	*Emberiza chrysophrys*
Little Bunting	*Emberiza pusilla*
Rustic Bunting	*Emberiza rustica*
Yellow-throated Bunting	*Emberiza elegans*
Yellow-breasted Bunting	*Emberiza aureola*
Gray Bunting	*Emberiza variabilis*
Pallas's Bunting	*Emberiza pallasi*
Reed Bunting	*Emberiza schoeniclus*
Hepatic Tanager	*Piranga flava*
Summer Tanager	*Piranga rubra*
Scarlet Tanager	*Piranga olivacea*
Western Tanager	*Piranga ludoviciana*
Flame-colored Tanager	*Piranga bidentata*
Crimson-collared Grosbeak	*Rhodothraupis celaeno*
Northern Cardinal	*Cardinalis cardinalis*
Pyrrhuloxia	*Cardinalis sinuatus*
Yellow Grosbeak	*Pheucticus chrysopeplus*
Rose-breasted Grosbeak	*Pheucticus ludovicianus*
Black-headed Grosbeak	*Pheucticus melanocephalus*
Blue Bunting	*Cyanocompsa parellina*

(*continued on next page*)

Woodland Birds (Continued)	Severity (Continued)
Individual	**1**
Common Name	**Scientific Name**
Blue Grosbeak	*Passerina caerulea*
Lazuli Bunting	*Passerina amoena*
Indigo Bunting	*Passerina cyanea*
Varied Bunting	*Passerina versicolor*
Painted Bunting	*Passerina ciris*
Dickcissel	*Spiza americana*
Black-vented Oriole	*Icterus wagleri*
Orchard Oriole	*Icterus spurius*
Hooded Oriole	*Icterus cucullatus*
Venezuelan Troupial	*Icterus icterus*
Streak-backed Oriole	*Icterus pustulatus*
Bullock's Oriole	*Icterus bullockii*
Spot-breasted Oriole	*Icterus pectoralis*
Altamira Oriole	*Icterus gularis*
Audubon's Oriole	*Icterus graduacauda*
Baltimore Oriole	*Icterus galbula*
Scott's Oriole	*Icterus parisorum*
Montezuma Oropendola	*Psarocolius montezuma*
Common Chaffinch	*Fringilla coelebs*
Brambling	*Fringilla montifringilla*
Asian Rosy-Finch	*Leucosticte arctoa*
Gray-crowned Rosy-Finch	*Leucosticte tephrocotis*
Black Rosy-Finch	*Leucosticte atrata*
Brown-capped Rosy-Finch	*Leucosticte australis*
Trumpeter Finch	*Bucanetes githagineus*
Pine Grosbeak	*Pinicola enucleator*
Eurasian Bullfinch	*Pyrrhula pyrrhula*
Laysan Finch	*Telespiza cantans*
Nihoa Finch	*Telespiza ultima*
Ou	*Psittirostra psittacea*
Palila	*Loxioides bailleui*
Maui Parrotbill	*Pseudonestor xanthophrys*
Hawaii Amakihi	*Hemignathus virens*
Oahu Amakihi	*Hemignathus flavus*
Kauai Amakihi	*Hemignathus kauaiensis*
Nukupuu	*Hemignathus lucidus*
Akiapolaau	*Hemignathus munroi*

(*continued on next page*)

Woodland Birds (Continued)	**Severity (Continued)**
Individual	**1**
Common Name	**Scientific Name**
Anianiau	*Magumma parva*
Akikiki	*Oreomystis bairdi*
Oahu Alauahio	*Paroreomyza maculata*
Maui Alauahio	*Paroreomyza montana*
Hawaii Creeper	*Loxops mana*
Akekee	*Loxops caeruleirostris*
Akepa	*Loxops coccineus*
Iiwi	*Vestiaria coccinea*
Akohekohe	*Palmeria dolei*
Apapane	*Himatione sanguinea*
Poo-uli	*Melamprosops phaeosoma*
Common Rosefinch	*Carpodacus erythrinus*
House Finch	*Haemorhous mexicanus*
Purple Finch	*Haemorhous purpureus*
Cassin's Finch	*Haemorhous cassinii*
Red Crossbill	*Loxia curvirostra*
White-winged Crossbill	*Loxia leucoptera*
Common Redpoll	*Acanthis flammea*
Hoary Redpoll	*Acanthis hornemanni*
Eurasian Siskin	*Spinus spinus*
Pine Siskin	*Spinus pinus*
Black-headed Siskin	*Spinus notatus*
Lesser Goldfinch	*Spinus psaltria*
Lawrence's Goldfinch	*Spinus lawrencei*
American Goldfinch	*Spinus tristis*
European Goldfinch	*Carduelis carduelis*
Oriental Greenfinch	*Chloris sinica*
Island Canary	*Serinus canaria*
Yellow-fronted Canary	*Serinus mozambicus*
European Serin	*Serinus serinus*
Evening Grosbeak	*Coccothraustes vespertinus*
Hawfinch	*Coccothraustes coccothraustes*
House Sparrow	*Passer domesticus*
Eurasian Tree Sparrow	*Passer montanus*
Northern Red Bishop	*Euplectes franciscanus*
Yellow-crowned Bishop	*Euplectes afer*
Red-cheeked Cordonbleu	*Uraeginthus bengalus*

(*continued on next page*)

Woodland Birds (Continued)	Severity (Continued)
Individual	**1**
Common Name	**Scientific Name**
Lavender Waxbill	*Estrilda caerulescens*
Orange-cheeked Waxbill	*Estrilda melpoda*
Black-rumped Waxbill	*Estrilda troglodytes*
Common Waxbill	*Estrilda astrild*
Red Avadavat	*Amandava amandava*
Zebra Finch	*Taeniopygia guttata*
Indian Silverbill	*Euodice malabarica*
African Silverbill	*Euodice cantans*
Madagascar Munia	*Lonchura nana*
Java Sparrow	*Lonchura oryzivora*
Scaly-breasted Munia	*Lonchura punctulata*
Tricolored Munia	*Lonchura malacca*
Chestnut Munia	*Lonchura atricapilla*
White-headed Munia	*Lonchura maja*
Pin-tailed Whydah	*Vidua macroura*
Corvids	**Severity**
Individual	**1**
If Flocks < 15	**4**
If Flocks ≥ 15	**5**
Common Name	**Scientific Name**
Gray Jay	*Perisoreus canadensis*
Black-throated Magpie-Jay	*Calocitta colliei*
Brown Jay	*Psilorhinus morio*
Green Jay	*Cyanocorax yncas*
Azure Jay	*Cyanocorax caeruleus*
Pinyon Jay	*Gymnorhinus cyanocephalus*
Steller's Jay	*Cyanocitta stelleri*
Blue Jay	*Cyanocitta cristata*
Florida Scrub-Jay	*Aphelocoma coerulescens*
Island Scrub-Jay	*Aphelocoma insularis*
Western Scrub-Jay	*Aphelocoma californica*
Mexican Jay	*Aphelocoma wollweberi*
Clark's Nutcracker	*Nucifraga columbiana*
Black-billed Magpie	*Pica hudsonia*
Yellow-billed Magpie	*Pica nuttalli*
Eurasian Jackdaw	*Corvus monedula*
American Crow	*Corvus brachyrhynchos*

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Corvids (Continued)	**Severity (Continued)**
Individual	**1**
If Flocks < 15	**4**
If Flocks ≥ 15	**5**
Common Name	**Scientific Name**
Northwestern Crow	*Corvus caurinus*
Tamaulipas Crow	*Corvus imparatus*
Fish Crow	*Corvus ossifragus*
Hawaiian Crow	*Corvus hawaiiensis*
Chihuahuan Raven	*Corvus cryptoleucus*
Common Raven	*Corvus corax*
Grassland Birds	**Severity**
Individual	**1**
Common Name	**Scientific Name**
Scissor-tailed Flycatcher	*Tyrannus forficatus*
Horned Lark	*Eremophila alpestris*
Olive-backed Pipit	*Anthus hodgsoni*
Pechora Pipit	*Anthus gustavi*
Red-throated Pipit	*Anthus cervinus*
American Pipit	*Anthus rubescens*
Sprague's Pipit	*Anthus spragueii*
Lapland Longspur	*Calcarius lapponicus*
Chestnut-collared Longspur	*Calcarius ornatus*
Smith's Longspur	*Calcarius pictus*
McCown's Longspur	*Rhynchophanes mccownii*
Snow Bunting	*Plectrophenax nivalis*
McKay's Bunting	*Plectrophenax hyperboreus*
Botteri's Sparrow	*Peucaea botterii*
Cassin's Sparrow	*Peucaea cassinii*
Bachman's Sparrow	*Peucaea aestivalis*
Clay-colored Sparrow	*Spizella pallida*
Brewer's Sparrow	*Spizella breweri*
Field Sparrow	*Spizella pusilla*
Worthen's Sparrow	*Spizella wortheni*
Vesper Sparrow	*Pooecetes gramineus*
Lark Sparrow	*Chondestes grammacus*
Lark Bunting	*Calamospiza melanocorys*
Savannah Sparrow	*Passerculus sandwichensis*
Grasshopper Sparrow	*Ammodramus savannarum*
Baird's Sparrow	*Ammodramus bairdii*
Henslow's Sparrow	*Ammodramus henslowii*
Le Conte's Sparrow	*Ammodramus leconteii*

(*continued on next page*)

Blackbirds/Starlings	Severity
Individual	**1**
If Flocks < 100	**4**
If Flocks ≥ 100	**5**
Common Name	**Scientific Name**
European Starling	*Sturnus vulgaris*
Common Myna	*Acridotheres tristis*
Crested Myna	*Acridotheres cristatellus*
Jungle Myna	*Acridotheres fuscus*
Common Hill Myna	*Gracula religiosa*
Bobolink	*Dolichonyx oryzivorus*
Red-winged Blackbird	*Agelaius phoeniceus*
Tricolored Blackbird	*Agelaius tricolor*
Tawny-shouldered Blackbird	*Agelaius humeralis*
Eastern Meadowlark	*Sturnella magna*
Western Meadowlark	*Sturnella neglecta*
Yellow-headed Blackbird	*Xanthocephalus xanthocephalus*
Rusty Blackbird	*Euphagus carolinus*
Brewer's Blackbird	*Euphagus cyanocephalus*
Common Grackle	*Quiscalus quiscula*
Boat-tailed Grackle	*Quiscalus major*
Great-tailed Grackle	*Quiscalus mexicanus*
Shiny Cowbird	*Molothrus bonariensis*
Bronzed Cowbird	*Molothrus aeneus*
Brown-headed Cowbird	*Molothrus ater*
Miscellaneous	**Severity**
Individual	**1**
Common Name	**Scientific Name**
Ringed Kingfisher	*Megaceryle torquata*
Belted Kingfisher	*Megaceryle alcyon*
Amazon Kingfisher	*Chloroceryle amazona*
Green Kingfisher	*Chloroceryle americana*
American Dipper	*Cinclus mexicanus*
Lesser Roadrunner	*Geococcyx velox*
Greater Roadrunner	*Geococcyx californianus*

Source: BASH Inc

Attachment 7: The EZ-Version WHaMRAT Mammalian Species List by Guild and Severity Score

Rodents	
Common Name	**Scientific Name**
Aplodontia	*Aplodontia rufa*
American beaver	*Castor canadensis*
Woodland jumping mouse	*Napaeozapus insignis*
Meadow jumping mouse	*Zapus hudsonius*
Western jumping mouse	*Zapus princeps*
Pacific jumping mouse	*Zapus trinotatus*
North American porcupine	*Erethizon dorsatum*
Southeastern pocket gopher	*Geomys pinetis*
Desert pocket gopher	*Geomys arenarius*
Plains pocket gopher	*Geomys bursarius*
Jones's pocket gopher	*Geomys knoxjonesi*
Texas pocket gopher	*Geomys personatus*
Baird's pocket gopher	*Geomys breviceps*
Llano pocket gopher	*Geomys texensis*
Attwater's pocket gopher	*Geomys attwateri*
Yellow-faced pocket gopher	*Cratogeomys castanops*
Northern pocket gopher	*Thomomys talpoides*
Western pocket gopher	*Thomomys mazama*
Botta's pocket gopher	*Thomomys bottae*
Southern pocket gopher	*Thomomys umbrinus*
Wyoming pocket gopher	*Thomomys clusius*
Idaho pocket gopher	*Thomomys idahoensis*
Mountain pocket gopher	*Thomomys monticola*
Townsend's pocket gopher	*Thomomys townsendii*
Camas pocket gopher	*Thomomys bulbivorus*
Mexican spiny pocket mouse	*Liomys irroratus*
Ord's kangaroo rat	*Dipodomys ordii*
Gulf Coast kangaroo rat	*Dipodomys compactus*
Chisel-toothed kangaroo rat	*Dipodomys microps*
Panamint kangaroo rat	*Dipodomys panamintinus*
Stephen's kangaroo rat	*Dipodomys stephensi*
Narrow-faced kangaroo rat	*Dipodomys venustus*
Agile kangaroo rat	*Dipodomys agilis*
Dulzura kangaroo rat	*Dipodomys simulans*
California kangaroo rat	*Dipodomys californicus*
Heermann's kangaroo rat	*Dipodomys heermanni*

(*continued on next page*)

Rodents (Continued)	
Common Name	**Scientific Name**
Giant kangaroo rat	*Dipodomys ingens*
Banner-tailed kangaroo rat	*Dipodomys spectabilis*
Texas kangaroo rat	*Dipodomys elator*
Desert kangaroo rat	*Dipodomys deserti*
Merriam's kangaroo rat	*Dipodomys merriami*
San Joaquin kangaroo rat	*Dipodomys nitratoides*
Dark kangaroo mouse	*Microdipodops megacephalus*
Pale kangaroo mouse	*Microdipodops pallidus*
Olive-backed pocket mouse	*Perognathus fasciatus*
Plains pocket mouse	*Perognathus flavescens*
Great Basin pocket mouse	*Perognathus parvus*
White-eared pocket mouse	*Perognathus alticola*
Silky pocket mouse	*Perognathus flavus*
Merriam's pocket mouse	*Perognathus merriami*
Little pocket mouse	*Perognathus longimembris*
Arizona pocket mouse	*Perognathus amplus*
San Joaquin pocket mouse	*Perognathus inornatus*
Bailey's pocket mouse	*Chaetodipus baileyi*
Baja pocket mouse	*Chaetodipus rudinoris*
Hispid pocket mouse	*Chaetodipus hispidus*
Desert pocket mouse	*Chaetodipus penicillatus*
Chihuahuan pocket mouse	*Chaetodipus eremicus*
Rock pocket mouse	*Chaetodipus intermedius*
Nelson's pocket mouse	*Chaetodipus nelsoni*
San Diego pocket mouse	*Chaetodipus fallax*
California pocket mouse	*Chaetodipus californicus*
Spiny pocket mouse	*Chaetodipus spinatus*
Long-tailed pocket mouse	*Chaetodipus formosus*
Eastern gray squirrel	*Sciurus carolinensis*
Red-bellied squirrel	*Sciurus aureogaster*
Eastern fox squirrel	*Sciurus niger*
Mexican fox squirrel	*Sciurus nayaritensis*
Arizona gray squirrel	*Sciurus arizonensis*
Western gray squirrel	*Sciurus griseus*
Abert's squirrel	*Sciurus aberti*
American red squirrel	*Tamiasciurus hudsonicus*
Douglas's squirrel	*Tamiasciurus douglasii*
Northern flying squirrel	*Glaucomys sabrinus*
Southern flying squirrel	*Glaucomys volans*
Harris's antelope squirrel	*Ammospermophilus harrisii*

(*continued on next page*)

Rodents (Continued)	
Common Name	**Scientific Name**
White-tailed antelope squirrel	*Ammospermophilus leucurus*
Texas antelope squirrel	*Ammospermophilus interpres*
Nelson's antelope squirrel	*Ammospermophilus nelsoni*
Black-tailed prairie dog	*Cynomys ludovicianus*
White-tailed prairie dog	*Cynomys leucurus*
Utah prairie dog	*Cynomys parvidens*
Gunnison's prairie dog	*Cynomys gunnisoni*
Woodchuck	*Marmota monax*
Yellow-bellied marmot	*Marmota flaviventris*
Hoary marmot	*Marmota caligata*
Alaska marmot	*Marmota broweri*
Olympic Marmot	*Marmota olympus*
Vancouver Island marmot	*Marmota vancouverensis*
California ground squirrel	*Otospermophilus beecheyi*
Rock squirrel	*Otospermophilus variegatus*
Golden-mantled ground squirrel	*Callospermophilus lateralis*
Cascade ground squirrel	*Callospermophilus saturatus*
Mohave ground squirrel	*Xerospermophilus mohavensis*
Spotted ground squirrel	*Xerospermophilus spilosoma*
Round-tailed ground squirrel	*Xerospermophilus tereticaudus*
Franklin's ground squirrel	*Poliocitellus franklinii*
Mexican ground squirrel	*Ictidomys mexicanus*
Thirteen-lined ground squirrel	*Ictidomys tridecemlineatus*
Uinta ground squirrel	*Urocittelus armatus*
Belding's ground squirrel	*Urocittelus beldingi*
Idaho ground squirrel	*Urocittelus richardsonii*
Merriam's ground squirrel	*Urocittelus canus*
Columbian ground squirrel	*Urocittelus columbianus*
Wyoming ground squirrel	*Urocittelus elegans*
Arctic ground squirrel	*Urocittelus parryii*
Townsend's ground squirrel	*Urocittelus townsendii*
Great Basin ground squirrel	*Urocittelus mollis*
Columbia Plateau ground squirrel	*Urocittelus canus*
Washington ground squirrel	*Urocittelus washingtoni*
Eastern chipmunk	*Tamias striatus*
Alpine chipmunk	*Tamias alpinus*
Least chipmunk	*Tamias minimus*
Yellow-pine chipmunk	*Tamias amoenus*
Townsend's chipmunk	*Tamias townsendii*
Allen's chipmunk	*Tamias senex*

(*continued on next page*)

Rodents (Continued)	
Common Name	**Scientific Name**
Yellow-cheeked chipmunk	*Tamias ochrogenys*
Siskiyou chipmunk	*Tamias siskiyou*
Sonoma chipmunk	*Tamias sonomae*
Merriam's chipmunk	*Tamias merriami*
California chipmunk	*Tamias obscurus*
Cliff chipmunk	*Tamias dorsalis*
Colorado chipmunk	*Tamias quadrivittatus*
Hopi chipmunk	*Tamias rufus*
Red-tailed chipmunk	*Tamias ruficaudus*
Gray-footed chipmunk	*Tamias canipes*
Gray-collared chipmunk	*Tamias cinereicollis*
Long-eared chipmunk	*Tamias quadrimaculatus*
Lodgepole chipmunk	*Tamias speciosus*
Panamint chipmunk	*Tamias panamintinus*
Uinta chipmunk	*Tamias umbrinus*
Palmer's chipmunk	*Tamias palmeri*
Meadow vole	*Microtus pennsylvanicus*
Beach vole	*Microtus breweri*
Montane vole	*Microtus montanus*
Gray-tailed vole	*Microtus canicaudus*
California vole	*Microtus californicus*
Townsend's vole	*Microtus townsendii*
Tundra vole	*Microtus oeconomus*
Long-tailed vole	*Microtus longicaudus*
Creeping vole	*Microtus oregoni*
Rock vole	*Microtus chrotorrhinus*
Taiga vole	*Microtus xanthognathus*
Prairie vole	*Microtus ochrogaster*
Mexican vole	*Microtus mexicanus*
Woodland vole	*Microtus pinetorum*
Singing vole	*Microtus miurus*
Insular vole	*Microtus abbreviatus*
Water vole	*Microtus richardsoni*
Sagebrush vole	*Lemmiscus curtatus*
White-footed vole	*Arborimus albipes*
Red tree vole	*Arborimus longicaudus*
Sonoma tree vole	*Arborimus pomo*
Western heather vole	*Phenacomys intermedius*
Eastern heather vole	*Phenacomys ungava*
Western red-backed vole	*Myodes californicus*

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Rodents (Continued)	
Common Name	**Scientific Name**
Southern red-backed vole	*Myodes gapperi*
Northern red-backed vole	*Myodes rutilus*
Northern bog lemming	*Synaptomys borealis*
Southern bog lemming	*Synaptomys cooperi*
Brown lemming	*Lemmus trimucronatus*
Northern collared lemming	*Dicrostonyx groenlandicus*
Ungave collared lemming	*Dicrostonyx hudsonius*
Richardson's collared lemming	*Dicrostonyx richardsoni*
Common muskrat	*Ondatra zibethicus*
Round-tailed muskrat	*Neofiber alleni*
Eastern woodrat	*Neotoma floridana*
Allegheny woodrat	*Neotoma magister*
Southern Plains woodrat	*Neotoma micropus*
Western white-throated woodrat	*Neotoma albigula*
Eastern white-throated woodrat	*Neotoma leucodon*
Desert woodrat	*Neotoma lepida*
Arizona woodrat	*Neotoma devia*
Stephens's woodrat	*Neotoma stephensi*
Mexican woodrat	*Neotoma mexicana*
Dusky-footed woodrat	*Neotoma fuscipes*
Big-eared woodrat	*Neotoma macrotis*
Bushy-tailed woodrat	*Neotoma cinerea*
Northern pygmy mouse	*Baiomys taylori*
Golden mouse	*Ochrotomys nuttalli*
Cactus mouse	*Peromyscus eremicus*
Northern Baja mouse	*Peromyscus fraterculus*
Mesquite mouse	*Peromyscus merriami*
California mouse	*Peromyscus californicus*
Oldfield mouse	*Peromyscus polionotus*
Keen's mouse	*Peromyscus keeni*
American deer mouse	*Peromyscus maniculatus*
White-footed mouse	*Peromyscus leucopus*
Cotton mouse	*Peromyscus gossypinus*
Canyon mouse	*Peromyscus crinitus*
White-ankled mouse	*Peromyscus pectoralis*
Brush mouse	*Peromyscus boylii*
Texas mouse	*Peromyscus attwateri*
Pinon mouse	*Peromyscus truei*
Osgood's mouse	*Peromyscus gratus*
Northern pocket mouse	*Peromyscus nasutus*

(*continued on next page*)

Rodents (Continued)	
Common Name	**Scientific Name**
Florida mouse	*Podomys floridanus*
Plains harvest mouse	*Reithrodontomys montanus*
Eastern harvest mouse	*Reithrodontomys humulis*
Western harvest mouse	*Reithrodontomys megalotis*
Salt-marsh harvest mouse	*Reithrodontomys raviventris*
Fulvous harvest mouse	*Reithrodontomys fulvescens*
Northern grasshopper mouse	*Onychomys leucogaster*
Southern grasshopper mouse	*Onychomys torridus*
Mearn's grasshopper mouse	*Onychomys arenicola*
Hispid cotton rat	*Sigmodon hispidus*
Arizona cotton rat	*Sigmodon arizonae*
Tawny-bellied cotton rat	*Sigmodon fulviventer*
Yellow-nosed cotton rat	*Sigmodon ochrognathus*
Coues's rice rat	*Oryzomys couesi*
Marsh rice rat	*Oryzomys palustris*
House mouse	*Mus musculus*
Black rat	*Rattus rattus*
Norway rat	*Rattus norvegicus*
Nutria	*Myocastor coypus*
Northern short-tailed shrew	*Blarina brevicauda*
Southern short-tailed shrew	*Blarina carolinensis*
Elliot's short-tailed shrew	*Blarina hylophaga*
Least shrew	*Cryptotis parva*
Desert shrew	*Notiosorex crawfordi*
Arctic shrew	*Sorex arcticus*
Maritime shrew	*Sorex maritimensis*
Tundra shrew	*Sorex tundrensis*
Alaska tiny shrew	*Sorex yukonicus*
Marsh shrew	*Sorex bendirii*
American water shrew	*Sorex palustris*
Smoky shrew	*Sorex fumeus*
Rock shrew	*Sorex dispar*
Gaspe shrew	*Sorex gaspensis*
Barren ground shrew	*Sorex ugyunak*
Saint Lawrence Island shrew	*Sorex jacksoni*
Pribilof Island shrew	*Sorex hydrodromus*
Masked shrew	*Sorex cinereus*
Hayden's shrew	*Sorex haydeni*
Mount Lyell shrew	*Sorex lyelli*
Southeastern shrew	*Sorex longirostris*

(*continued on next page*)

Rodents (Continued)	
Common Name	**Scientific Name**
Preble's shrew	*Sorex preblei*
Pacific shrew	*Sorex pacificus*
Fog shrew	*Sorex sonomae*
Baird's shrew	*Sorex bairdi*
Montane shrew	*Sorex monticolus*
New Mexico shrew	*Sorex neomexicanus*
Vagrant shrew	*Sorex vagrans*
Ornate shrew	*Sorex ornatus*
Dwarf shrew	*Sorex nanus*
Inyo shrew	*Sorex tenellus*
Pygmy shrew	*Sorex hoyi*
Arizona shrew	*Sorex arizonae*
Merriam's shrew	*Sorex merriami*
Trowbridge's shrew	*Sorex trowbridgii*
American shrew mole	*Neurotrichus gibbsii*
Broad-footed mole	*Scapanus latimanus*
Coast mole	*Scapanus orarius*
Townsend's mole	*Scapanus townsendii*
Hairy-tailed mole	*Parascalops breweri*
Eastern mole	*Scalopus aquaticus*
Star-nosed mole	*Condylura cristata*
Lagomorphs	
Common Name	**Scientific Name**
Collared pika	*Ochotona collaris*
American pika	*Ochotona princeps*
Pygmy rabbit	*Brachylagus idahoensis*
Brush rabbit	*Sylvilagus bachmani*
Swamp rabbit	*Sylvilagus aquaticus*
Marsh rabbit	*Sylvilagus palustris*
Eastern cottontail	*Sylvilagus floridanus*
New England cottontail	*Sylvilagus transitionalis*
Appalachian cottontail	*Sylvilagus obscurus*
Mountain cottontail	*Sylvilagus nuttallii*
Desert cottontail	*Sylvilagus audubonii*
European rabbit	*Oryctolagus cuniculus*
Snowshoe hare	*Lepus americanus*
Alaskan hare	*Lepus othus*
Arctic hare	*Lepus arcticus*
White-tailed jackrabbit	*Lepus townsendii*
Black-tailed jackrabbit	*Lepus californicus*

(*continued on next page*)

Lagomorphs (Continued)	
Common Name	**Scientific Name**
White-sided jackrabbit	*Lepus callotis*
Antelope jackrabbit	*Lepus alleni*
European hare	*Lepus capensis*
Bats	
Common Name	**Scientific Name**
Western pipistrelle	*Pipistrellus hesperus*
Eastern pipistrelle	*Pipistrellus subflavus*
Big brown bat	*Eptesicus fuscus*
Evening bat	*Nycticeius humeralis*
Southern yellow bat	*Lasiurus ega*
Western yellow bat	*Lasiurus xanthinus*
Northern yellow bat	*Lasiurus intermedius*
Eastern red bat	*Lasiurus borealis*
Western red bat	*Lasiurus blossevillii*
Seminole bat	*Lasiurus seminolus*
Hoary bat	*Lasiurus cinereus*
Spotted bat	*Euderma maculatum*
Rafinesque's big-eared bat	*Corynorhinus rafinesquii*
Townsend's big-eared bat	*Corynorhinus townsendii*
California myotis	*Myotis californicus*
Western small-footed myotis	*Myotis ciliolabrum*
Eastern small-footed myotis	*Myotis leibii*
Yuma myotis	*Myotis yumanensis*
Little brown bat	*Myotis lucifugus*
Arizona myotis	*Myotis occultus*
Indiana myotis	*Myotis sodalis*
Southeastern myotis	*Myotis austroriparius*
Cave myotis	*Myotis velifer*
Gray myotis	*Myotis grisescens*
Long-legged myotis	*Myotis volans*
Northern myotis	*Myotis septentrionalis*
Southwestern myotis	*Myotis auriculus*
Long-eared myotis	*Myotis evotis*
Keen's myotis	*Myotis keenii*
Fringed myotis	*Myotis thysanodes*
Florida bonneted bat	*Eumops floridanus*
Western bonneted bat	*Eumops perotis*
Underwood's bonneted bat	*Eumops underwoodi*
Little mastiff bat	*Molossus molossus*

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Bats	
Common Name	**Scientific Name**
Pocketed free-tailed bat	*Nyctinomops femorosaccus*
Big free-tailed bat	*Nyctinomops macrotis*
Brazilian free-tailed bat	*Tadarida brasiliensis*
Pallid bat	*Antrozous pallidus*
Peter's ghost-faced bat	*Mormoops megalophylla*
California leaf-nosed bat	*Macrotus californicus*
Silver-haired bat	*Lasionycteris noctivagans*
Allen's big-eared bat	*Idionycteris phyllotis*
Cuban flower bat	*Phyllonycteris poeyi*
Mexican long-tongued bat	*Choeronycteris mexicana*
Buffy flower bat	*Erophylla sezekorni*
Hairy-legged vampire bat	*Diphylla ecaudata*
Lesser long-nosed bat	*Leptonycteris yerbabuenae*
Mexican long-nosed bat	*Leptonycteris nivalis*
Jamaican fruit-eating bat	*Artibeus jamaicensis*
Cuban fig-eating bat	*Phyllops falcatus*
Mesomammals	
Common Name	**Scientific Name**
Virginia opossum	*Didelphis virginiana*
Nine-banded armadillo	*Dasypus novemcinctus*
Ringtail	*Bassariscus astutus*
Northern raccoon	*Procyon lotor*
White-nosed coati	*Nasua narica*
Western spotted skunk	*Spilogale gracilis*
Eastern spotted skunk	*Spilgale putorius*
Striped skunk	*Mephitis mephitis*
White-backed hog-nosed skunk	*Conepatus leuconotus*
Hooded skunk	*Mephitis macroura*
American marten	*Martes americana*
Fisher	*Martes pennanti*
Least weasel	*Mustela nivalis*
Short-tailed weasel	*Mustela erminea*
Long-tailed weasel	*Mustela frenata*
American mink	*Mustela vison*
Black-footed ferret	*Mustela nigripes*
Wolverine	*Gulo gulo*
American badger	*Taxidea taxus*
Northern river otter	*Lontra canadensis*

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Canids	
Common Name	**Scientific Name**
Coyote	*Canis latrans*
Domestic/feral dog	*Canis familiiaris*
Gray wolf	*Canis lupus*
Eastern timber wolf	*Canis lycaon*
Red wolf	*Canis rufus*
Arctic fox	*Alopex lagopus*
Swift fox	*Vulpes velox*
Kit fox	*Vulpes macrotis*
Red fox	*Vulpes vulpes*
Gray fox	*Urocyon cinereoargenteus*
Island gray fox	*Urocyon littoralis*
Felids	
Common Name	**Scientific Name**
Cougar	*Puma concolor*
Ocelot	*Leopardus pardalis*
Jaguarundi	*Herpailurus yagouaroundi*
Bobcat	*Lynx rufus*
Canada lynx	*Lynx canadensis*
Jaguar	*Panthera onca*
Domestic/feral cat	*Felis catus*
Hooved	
Common Name	**Scientific Name**
Wild boar	*Sus scrofa*
Collared peccary	*Tayassu tajacu*
Elk	*Cervus elaphus*
Sika deer	*Cervus nippon*
Sambar deer	*Cervus unicolor*
Axis deer	*Axis axis*
Fallow deer	*Dama dama*
White-tailed deer	*Odocoileus virginianus*
Mule deer	*Odocoileus hemionus*
Moose	*Alces alces*
Caribou	*Rangifer tarandus*
Pronghorn	*Antilocapra americana*
Nilgai	*Boselaphus tragocamelus*
American bison	*Bos bison*
Blackbuck	*Antilope cervicapra*
Mountain goat	*Oreamnos americanus*
Muskox	*Ovibos moschatus*

(*continued on next page*)

Hooved	
Common Name	**Scientific Name**
Barbary sheep	*Ammotragus lervia*
Bighorn sheep	*Ovis canadensis*
Dall's sheep	*Ovis dalli*
European mouflon	*Ovis musimon*
Feral donkey	*Equus asinus*
Feral horse	*Equus ferus*
Bears	
Common Name	**Scientific Name**
Black bear	*Ursus americanus*
Brown bear	*Ursus arctos*
Polar bear	*Ursus maritimus*

Source BASH Inc.

Attachment 8: The Advanced-Version WHaMRAT Avian Species List by Guild and Severity Score

Weights expressed in grams (g)

Waterbirds			
Common Name	**Scientific Name**	**Guild (Mass)**	**Severity**
Least Grebe	*Tachybaptus dominicus*	Waterbirds <300g	**1**
Yellow Rail	*Coturnicops noveboracensis*	Waterbirds <300g	**1**
Black Rail	*Laterallus jamaicensis*	Waterbirds <300g	**1**
Corn Crake	*Crex crex*	Waterbirds <300g	**1**
Ridgway's Rail	*Rallus obsoletus*	Waterbirds <300g	**1**
Clapper Rail	*Rallus crepitans*	Waterbirds <300g	**1**
King Rail	*Rallus elegans*	Waterbirds <300g	**1**
Virginia Rail	*Rallus limicola*	Waterbirds <300g	**1**
Rufous-necked Wood-Rail	*Aramides axillaris*	Waterbirds <300g	**1**
Gray-necked Wood-Rail	*Aramides cajaneus*	Waterbirds <300g	**1**
Sora	*Porzana carolina*	Waterbirds <300g	**1**
Paint-billed Crake	*Neocrex erythrops*	Waterbirds <300g	**1**
Spotted Rail	*Pardirallus maculatus*	Waterbirds <300g	**1**
Purple Swamphen	*Porphyrio porphyrio*	Waterbirds <300g	**1**
Purple Gallinule	*Porphyrio martinicus*	Waterbirds <300g	**1**
Azure Gallinule	*Porphyrio flavirostris*	Waterbirds <300g	**1**
Common Gallinule	*Gallinula galeata*	Waterbirds <300g	**1**
Sungrebe	*Heliornis fulica*	Waterbirds <300g	**1**
Pied-billed Grebe	*Podilymbus podiceps*	Waterbirds 300-999g	**2**
Horned Grebe	*Podiceps auritus*	Waterbirds 300-999g	**2**
Eared Grebe	*Podiceps nigricollis*	Waterbirds 300-999g	**2**
Common Moorhen	*Gallinula chloropus*	Waterbirds 300-999g	**2**
Eurasian Coot	*Fulica atra*	Waterbirds 300-999g	**2**
Hawaiian Coot	*Fulica alai*	Waterbirds 300-999g	**2**
American Coot	*Fulica americana*	Waterbirds 300-999g	**2**
Red-throated Loon	*Gavia stellata*	Waterbirds 1000-1999g	**3**
Arctic Loon	*Gavia arctica*	Waterbirds 1000-1999g	**3**
Pacific Loon	*Gavia pacifica*	Waterbirds 1000-1999g	**3**
Red-necked Grebe	*Podiceps grisegena*	Waterbirds 1000-1999g	**3**
Western Grebe	*Aechmophorus occidentalis*	Waterbirds 1000-1999g	**3**
Clark's Grebe	*Aechmophorus clarkii*	Waterbirds 1000-1999g	**3**

(*continued on next page*)

Waterbirds (Continued)			
Common Name	**Scientific Name**	**Guild (Mass)**	**Severity**
Common Loon	*Gavia immer*	Waterbirds 2000-3999g	**4**
Yellow-billed Loon	*Gavia adamsii*	Waterbirds >4000g	**5**
Seabirds			
Common Name	**Scientific Name**	**Guild (Mass)**	**Severity**
Juan Fernandez Petrel	*Pterodroma externa*	Seabirds <300g	**1**
Bonin Petrel	*Pterodroma hypoleuca*	Seabirds <300g	**1**
Black-winged Petrel	*Pterodroma nigripennis*	Seabirds <300g	**1**
Phoenix Petrel	*Pterodroma alba*	Seabirds <300g	**1**
Jouanin's Petrel	*Bulweria fallax*	Seabirds <300g	**1**
Wilson's Storm-Petrel	*Oceanites oceanicus*	Seabirds <300g	**1**
White-faced Storm-Petrel	*Pelagodroma marina*	Seabirds <300g	**1**
European Storm-Petrel	*Hydrobates pelagicus*	Seabirds <300g	**1**
Fork-tailed Storm-Petrel	*Oceanodroma furcata*	Seabirds <300g	**1**
Ringed Storm-Petrel	*Oceanodroma hornbyi*	Seabirds <300g	**1**
Swinhoe's Storm-Petrel	*Oceanodroma monorhis*	Seabirds <300g	**1**
Leach's Storm-Petrel	*Oceanodroma leucorhoa*	Seabirds <300g	**1**
Ashy Storm-Petrel	*Oceanodroma homochroa*	Seabirds <300g	**1**
Band-rumped Storm-Petrel	*Oceanodroma castro*	Seabirds <300g	**1**
Wedge-rumped Storm-Petrel	*Oceanodroma tethys*	Seabirds <300g	**1**
Black Storm-Petrel	*Oceanodroma melania*	Seabirds <300g	**1**
Tristram's Storm-Petrel	*Oceanodroma tristrami*	Seabirds <300g	**1**
Least Storm-Petrel	*Oceanodroma microsoma*	Seabirds <300g	**1**
Dovekie	*Alle alle*	Seabirds <300g	**1**
Long-billed Murrelet	*Brachyramphus perdix*	Seabirds <300g	**1**
Marbled Murrelet	*Brachyramphus marmoratus*	Seabirds <300g	**1**
Kittlitz's Murrelet	*Brachyramphus brevirostris*	Seabirds <300g	**1**
Scripps's Murrelet	*Synthliboramphus scrippsi*	Seabirds <300g	**1**
Guadalupe Murrelet	*Synthliboramphus hypoleucus*	Seabirds <300g	**1**
Craveri's Murrelet	*Synthliboramphus craveri*	Seabirds <300g	**1**
Ancient Murrelet	*Synthliboramphus antiquus*	Seabirds <300g	**1**
Cassin's Auklet	*Ptychoramphus aleuticus*	Seabirds <300g	**1**

(*continued on next page*)

Seabirds (Continued)			
Common Name	**Scientific Name**	**Guild (Mass)**	**Severity**
Least Auklet	*Aethia pusilla*	Seabirds <300g	**1**
Whiskered Auklet	*Aethia pygmaea*	Seabirds <300g	**1**
Crested Auklet	*Aethia cristatella*	Seabirds <300g	**1**
Southern Giant-Petrel	*Macronectes giganteus*	Seabirds 300-999g	**2**
Short-tailed Albatross	*Phoebastria albatrus*	Seabirds 300-999g	**2**
Northern Fulmar	*Fulmarus glacialis*	Seabirds 300-999g	**2**
Great-winged Petrel	*Pterodroma macroptera*	Seabirds 300-999g	**2**
Providence Petrel	*Pterodroma solandri*	Seabirds 300-999g	**2**
Zino's Petrel	*Pterodroma madeira*	Seabirds 300-999g	**2**
Kermadec Petrel	*Pterodroma neglecta*	Seabirds 300-999g	**2**
Trindade Petrel	*Pterodroma arminjoniana*	Seabirds 300-999g	**2**
Murphy's Petrel	*Pterodroma ultima*	Seabirds 300-999g	**2**
Mottled Petrel	*Pterodroma inexpectata*	Seabirds 300-999g	**2**
Bermuda Petrel	*Pterodroma cahow*	Seabirds 300-999g	**2**
Black-capped Petrel	*Pterodroma hasitata*	Seabirds 300-999g	**2**
Hawaiian Petrel	*Pterodroma sandwichensis*	Seabirds 300-999g	**2**
White-necked Petrel	*Pterodroma cervicalis*	Seabirds 300-999g	**2**
Fea's Petrel	*Pterodroma feae*	Seabirds 300-999g	**2**
Cook's Petrel	*Pterodroma cookii*	Seabirds 300-999g	**2**
Stejneger's Petrel	*Pterodroma longirostris*	Seabirds 300-999g	**2**
Bulwer's Petrel	*Bulweria bulwerii*	Seabirds 300-999g	**2**
Parkinson's Petrel	*Procellaria parkinsoni*	Seabirds 300-999g	**2**
Streaked Shearwater	*Calonectris leucomelas*	Seabirds 300-999g	**2**
Cory's Shearwater	*Calonectris diomedea*	Seabirds 300-999g	**2**
Cape Verde Shearwater	*Calonectris edwardsii*	Seabirds 300-999g	**2**
Pink-footed Shearwater	*Puffinus creatopus*	Seabirds 300-999g	**2**
Flesh-footed Shearwater	*Puffinus carneipes*	Seabirds 300-999g	**2**
Great Shearwater	*Puffinus gravis*	Seabirds 300-999g	**2**
Wedge-tailed Shearwater	*Puffinus pacificus*	Seabirds 300-999g	**2**
Buller's Shearwater	*Puffinus bulleri*	Seabirds 300-999g	**2**
Sooty Shearwater	*Puffinus griseus*	Seabirds 300-999g	**2**
Short-tailed Shearwater	*Puffinus tenuirostris*	Seabirds 300-999g	**2**
Christmas Shearwater	*Puffinus nativitatis*	Seabirds 300-999g	**2**
Manx Shearwater	*Puffinus puffinus*	Seabirds 300-999g	**2**
Townsend's Shearwater	*Puffinus auricularis*	Seabirds 300-999g	**2**
Bryan's Shearwater	*Puffinus bryani*	Seabirds 300-999g	**2**
Black-vented Shearwater	*Puffinus opisthomelas*	Seabirds 300-999g	**2**
Audubon's Shearwater	*Puffinus lherminieri*	Seabirds 300-999g	**2**

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Seabirds (Continued)			
Common Name	**Scientific Name**	**Guild (Mass)**	**Severity**
Barolo Shearwater	*Puffinus baroli*	Seabirds 300-999g	**2**
White-tailed Tropicbird	*Phaethon lepturus*	Seabirds 300-999g	**2**
Red-billed Tropicbird	*Phaethon aethereus*	Seabirds 300-999g	**2**
Red-tailed Tropicbird	*Phaethon rubricauda*	Seabirds 300-999g	**2**
Pomarine Jaeger	*Stercorarius pomarinus*	Seabirds 300-999g	**2**
Parasitic Jaeger	*Stercorarius parasiticus*	Seabirds 300-999g	**2**
Long-tailed Jaeger	*Stercorarius longicaudus*	Seabirds 300-999g	**2**
Common Murre	*Uria aalge*	Seabirds 300-999g	**2**
Thick-billed Murre	*Uria lomvia*	Seabirds 300-999g	**2**
Razorbill	*Alca torda*	Seabirds 300-999g	**2**
Great Auk	*Pinguinus impennis*	Seabirds 300-999g	**2**
Black Guillemot	*Cepphus grylle*	Seabirds 300-999g	**2**
Pigeon Guillemot	*Cepphus columba*	Seabirds 300-999g	**2**
Parakeet Auklet	*Aethia psittacula*	Seabirds 300-999g	**2**
Rhinoceros Auklet	*Cerorhinca monocerata*	Seabirds 300-999g	**2**
Atlantic Puffin	*Fratercula arctica*	Seabirds 300-999g	**2**
Horned Puffin	*Fratercula corniculata*	Seabirds 300-999g	**2**
Tufted Puffin	*Fratercula cirrhata*	Seabirds 300-999g	**2**
Magnificent Frigatebird	*Fregata magnificens*	Seabirds 1000-1999g	**3**
Great Frigatebird	*Fregata minor*	Seabirds 1000-1999g	**3**
Lesser Frigatebird	*Fregata ariel*	Seabirds 1000-1999g	**3**
Masked Booby	*Sula dactylatra*	Seabirds 1000-1999g	**3**
Nazca Booby	*Sula granti*	Seabirds 1000-1999g	**3**
Blue-footed Booby	*Sula nebouxii*	Seabirds 1000-1999g	**3**
Brown Booby	*Sula leucogaster*	Seabirds 1000-1999g	**3**
Red-footed Booby	*Sula sula*	Seabirds 1000-1999g	**3**
Northern Gannet	*Morus bassanus*	Seabirds 1000-1999g	**3**
Great Skua	*Stercorarius skua*	Seabirds 1000-1999g	**3**
South Polar Skua	*Stercorarius maccormicki*	Seabirds 1000-1999g	**3**
Yellow-nosed Albatross	*Thalassarche chlororhynchos*	Seabirds 2000-3999g	**4**
White-capped Albatross	*Thalassarche cauta*	Seabirds 2000-3999g	**4**
Salvin's Albatross	*Thalassarche salvini*	Seabirds 2000-3999g	**4**
Chatham Albatross	*Thalassarche eremita*	Seabirds 2000-3999g	**4**
Black-browed Albatross	*Thalassarche melanophris*	Seabirds 2000-3999g	**4**
Wandering Albatross	*Diomedea exulans*	Seabirds 2000-3999g	**4**
Light-mantled Albatross	*Phoebetria palpebrata*	Seabirds 2000-3999g	**4**

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Seabirds (Continued)			
Common Name	**Scientific Name**	**Guild (Mass)**	**Severity**
Laysan Albatross	*Phoebastria immutabilis*	Seabirds 2000-3999g	**4**
Black-footed Albatross	*Phoebastria nigripes*	Seabirds 2000-3999g	**4**
Short-tailed Albatross	*Phoebastria albatrus*	Seabirds 2000-3999g	**4**
Pelicans/Cormorants			
Common Name	**Scientific Name**	**Guild (Mass)**	**Severity**
Neotropic Cormorant	*Phalacrocorax brasilianus*	Pelicans 1000-1999g	**3**
Double-crested Cormorant	*Phalacrocorax auritus*	Pelicans 1000-1999g	**3**
Pelagic Cormorant	*Phalacrocorax pelagicus*	Pelicans 1000-1999g	**3**
Anhinga	*Anhinga anhinga*	Pelicans 1000-1999g	**3**
Brandt's Cormorant	*Phalacrocorax penicillatus*	Pelicans 2000-3999g	**4**
Great Cormorant	*Phalacrocorax carbo*	Pelicans 2000-3999g	**4**
Red-faced Cormorant	*Phalacrocorax urile*	Pelicans 2000-3999g	**4**
Brown Pelican	*Pelecanus occidentalis*	Pelicans 2000-3999g	**4**
American White Pelican	*Pelecanus erythrorhynchos*	Pelicans >4000g	**5**
Waders			
		If Flocks ≥ 5	**5**
Common Name	**Scientific Name**	**Guild (Mass)**	**Severity**
American Bittern	*Botaurus lentiginosus*	Waders 300-999g	**2**
Great Bittern	*Botaurus stellaris*	Waders 300-999g	**2**
Yellow Bittern	*Ixobrychus sinensis*	Waders 300-999g	**2**
Least Bittern	*Ixobrychus exilis*	Waders 300-999g	**2**
Great Egret	*Ardea alba*	Waders 300-999g	**2**
Intermediate Egret	*Mesophoyx intermedia*	Waders 300-999g	**2**
Chinese Egret	*Egretta eulophotes*	Waders 300-999g	**2**
Little Egret	*Egretta garzetta*	Waders 300-999g	**2**
Western Reef-Heron	*Egretta gularis*	Waders 300-999g	**2**
Snowy Egret	*Egretta thula*	Waders 300-999g	**2**
Little Blue Heron	*Egretta caerulea*	Waders 300-999g	**2**
Tricolored Heron	*Egretta tricolor*	Waders 300-999g	**2**
Reddish Egret	*Egretta rufescens*	Waders 300-999g	**2**
Cattle Egret	*Bubulcus ibis*	Waders 300-999g	**2**
Chinese Pond-Heron	*Ardeola bacchus*	Waders 300-999g	**2**
Green Heron	*Butorides virescens*	Waders 300-999g	**2**
Striated Heron	*Butorides striata*	Waders 300-999g	**2**
Black-crowned Night-Heron	*Nycticorax nycticorax*	Waders 300-999g	**2**

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Waders (Continued)			
		If Flocks ≥ 5	**5**
Common Name	**Scientific Name**	**Guild (Mass)**	**Severity**
Yellow-crowned Night-Heron	*Nyctanassa violacea*	Waders 300-999g	**2**
White Ibis	*Eudocimus albus*	Waders 300-999g	**2**
Scarlet Ibis	*Eudocimus ruber*	Waders 300-999g	**2**
Glossy Ibis	*Plegadis falcinellus*	Waders 300-999g	**2**
White-faced Ibis	*Plegadis chihi*	Waders 300-999g	**2**
Sacred Ibis	*Threskiornis aethiopicus*	Waders 300-999g	**2**
Gray Heron	*Ardea cinerea*	Waders 1000-1999g	**3**
Bare-throated Tiger-Heron	*Tigrisoma mexicanum*	Waders 1000-1999g	**3**
Roseate Spoonbill	*Platalea ajaja*	Waders 1000-1999g	**3**
Limpkin	*Aramus guarauna*	Waders 1000-1999g	**3**
Great Blue Heron	*Ardea herodias*	Waders 2000-3999g	**4**
American Flamingo	*Phoenicopterus ruber*	Waders >4000g	**5**
Chilean Flamingo	*Phoenicopterus chilensis*	Waders >4000g	**5**
Jabiru	*Jabiru mycteria*	Waders >4000g	**5**
Wood Stork	*Mycteria americana*	Waders >4000g	**5**
Waterfowl			
		If Flocks < 5	**4**
		If Flocks ≥ 5	**5**
Common Name	**Scientific Name**	**Guild (Mass)**	**Severity**
Black-bellied Whistling-Duck	*Dendrocygna autumnalis*	Waterfowl 300-999g	**2**
West Indian Whistling-Duck	*Dendrocygna arborea*	Waterfowl 300-999g	**2**
Fulvous Whistling-Duck	*Dendrocygna bicolor*	Waterfowl 300-999g	**2**
Wood Duck	*Aix sponsa*	Waterfowl 300-999g	**2**
Gadwall	*Anas strepera*	Waterfowl 300-999g	**2**
Falcated Duck	*Anas falcata*	Waterfowl 300-999g	**2**
Eurasian Wigeon	*Anas penelope*	Waterfowl 300-999g	**2**
American Wigeon	*Anas americana*	Waterfowl 300-999g	**2**
Hawaiian Duck	*Anas wyvilliana*	Waterfowl 300-999g	**2**
Laysan Duck	*Anas laysanensis*	Waterfowl 300-999g	**2**
Eastern Spot-billed Duck	*Anas zonorhyncha*	Waterfowl 300-999g	**2**
Blue-winged Teal	*Anas discors*	Waterfowl 300-999g	**2**
Cinnamon Teal	*Anas cyanoptera*	Waterfowl 300-999g	**2**
Northern Shoveler	*Anas clypeata*	Waterfowl 300-999g	**2**
White-cheeked Pintail	*Anas bahamensis*	Waterfowl 300-999g	**2**

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Waterfowl (Continued)			
		If Flocks < 5	4
		If Flocks ≥ 5	5
Common Name	**Scientific Name**	**Guild (Mass)**	**Severity**
Northern Pintail	*Anas acuta*	Waterfowl 300-999g	2
Garganey	*Anas querquedula*	Waterfowl 300-999g	2
Baikal Teal	*Anas formosa*	Waterfowl 300-999g	2
Green-winged Teal	*Anas crecca*	Waterfowl 300-999g	2
Common Pochard	*Aythya ferina*	Waterfowl 300-999g	2
Ring-necked Duck	*Aythya collaris*	Waterfowl 300-999g	2
Tufted Duck	*Aythya fuligula*	Waterfowl 300-999g	2
Greater Scaup	*Aythya marila*	Waterfowl 300-999g	2
Lesser Scaup	*Aythya affinis*	Waterfowl 300-999g	2
Harlequin Duck	*Histrionicus histrionicus*	Waterfowl 300-999g	2
Labrador Duck	*Camptorhynchus labradorius*	Waterfowl 300-999g	2
Surf Scoter	*Melanitta perspicillata*	Waterfowl 300-999g	2
White-winged Scoter	*Melanitta fusca*	Waterfowl 300-999g	2
Common Scoter	*Melanitta nigra*	Waterfowl 300-999g	2
Black Scoter	*Melanitta americana*	Waterfowl 300-999g	2
Long-tailed Duck	*Clangula hyemalis*	Waterfowl 300-999g	2
Bufflehead	*Bucephala albeola*	Waterfowl 300-999g	2
Common Goldeneye	*Bucephala clangula*	Waterfowl 300-999g	2
Barrow's Goldeneye	*Bucephala islandica*	Waterfowl 300-999g	2
Smew	*Mergellus albellus*	Waterfowl 300-999g	2
Masked Duck	*Nomonyx dominicus*	Waterfowl 300-999g	2
Ruddy Duck	*Oxyura jamaicensis*	Waterfowl 300-999g	2
Brant	*Branta bernicla*	Waterfowl 1000-1999g	3
Barnacle Goose	*Branta leucopsis*	Waterfowl 1000-1999g	3
Cackling Goose	*Branta hutchinsii*	Waterfowl 1000-1999g	3
Hawaiian Goose	*Branta sandvicensis*	Waterfowl 1000-1999g	3
American Black Duck	*Anas rubripes*	Waterfowl 1000-1999g	3
Mallard	*Anas platyrhynchos*	Waterfowl 1000-1999g	3
Mottled Duck	*Anas fulvigula*	Waterfowl 1000-1999g	3
Canvasback	*Aythya valisineria*	Waterfowl 1000-1999g	3
Redhead	*Aythya americana*	Waterfowl 1000-1999g	3
Hooded Merganser	*Lophodytes cucullatus*	Waterfowl 1000-1999g	3
Common Merganser	*Mergus merganser*	Waterfowl 1000-1999g	3
Red-breasted Merganser	*Mergus serrator*	Waterfowl 1000-1999g	3
Steller's Eider	*Polysticta stelleri*	Waterfowl 1000-1999g	3
Spectacled Eider	*Somateria fischeri*	Waterfowl 1000-1999g	3

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Waterfowl (Continued)			
		If Flocks < 5	**4**
		If Flocks ≥ 5	**5**
Common Name	**Scientific Name**	**Guild (Mass)**	**Severity**
King Eider	*Somateria spectabilis*	Waterfowl 1000-1999g	**3**
Taiga Bean-Goose	*Anser fabalis*	Waterfowl 2000-3999g	**4**
Tundra Bean-Goose	*Anser serrirostris*	Waterfowl 2000-3999g	**4**
Pink-footed Goose	*Anser brachyrhynchus*	Waterfowl 2000-3999g	**4**
Greater White-fronted Goose	*Anser albifrons*	Waterfowl 2000-3999g	**4**
Lesser White-fronted Goose	*Anser erythropus*	Waterfowl 2000-3999g	**4**
Graylag Goose	*Anser anser*	Waterfowl 2000-3999g	**4**
Bar-headed Goose	*Anser indicus*	Waterfowl 2000-3999g	**4**
Emperor Goose	*Chen canagica*	Waterfowl 2000-3999g	**4**
Snow Goose	*Chen caerulescens*	Waterfowl 2000-3999g	**4**
Ross's Goose	*Chen rossii*	Waterfowl 2000-3999g	**4**
Canada Goose	*Branta canadensis*	Waterfowl 2000-3999g	**4**
Orinoco Goose	*Neochen jubata*	Waterfowl 2000-3999g	**4**
Muscovy Duck	*Cairina moschata*	Waterfowl 2000-3999g	**4**
Common Eider	*Somateria mollissima*	Waterfowl 2000-3999g	**4**
Mute Swan	*Cygnus olor*	Waterfowl >4000g	**5**
Trumpeter Swan	*Cygnus buccinator*	Waterfowl >4000g	**5**
Tundra Swan	*Cygnus columbianus*	Waterfowl >4000g	**5**
Whooper Swan	*Cygnus cygnus*	Waterfowl >4000g	**5**
Raptors/Vultures/Owls			
Common Name	**Scientific Name**	**Guild (Mass)**	**Severity**
Hook-billed Kite	*Chondrohierax uncinatus*	Raptors <300g	**1**
Mississippi Kite	*Ictinia mississippiensis*	Raptors <300g	**1**
Chinese Sparrowhawk	*Accipiter soloensis*	Raptors <300g	**1**
Sharp-shinned Hawk	*Accipiter striatus*	Raptors <300g	**1**
Oriental Scops-Owl	*Otus sunia*	Raptors <300g	**1**
Flammulated Owl	*Psiloscops flammeolus*	Raptors <300g	**1**
Western Screech-Owl	*Megascops kennicottii*	Raptors <300g	**1**
Eastern Screech-Owl	*Megascops asio*	Raptors <300g	**1**
Whiskered Screech-Owl	*Megascops trichopsis*	Raptors <300g	**1**
Northern Pygmy-Owl	*Glaucidium gnoma*	Raptors <300g	**1**
Ferruginous Pygmy-Owl	*Glaucidium brasilianum*	Raptors <300g	**1**
Elf Owl	*Micrathene whitneyi*	Raptors <300g	**1**
Burrowing Owl	*Athene cunicularia*	Raptors <300g	**1**
Great Gray Owl	*Strix nebulosa*	Raptors <300g	**1**

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Raptors/Vultures/Owls (Continued)			
Common Name	**Scientific Name**	**Guild (Mass)**	**Severity**
Long-eared Owl	*Asio otus*	Raptors <300g	**1**
Stygian Owl	*Asio stygius*	Raptors <300g	**1**
Boreal Owl	*Aegolius funereus*	Raptors <300g	**1**
Northern Saw-whet Owl	*Aegolius acadicus*	Raptors <300g	**1**
Northern Boobook	*Ninox japonica*	Raptors <300g	**1**
Eurasian Kestrel	*Falco tinnunculus*	Raptors <300g	**1**
American Kestrel	*Falco sparverius*	Raptors <300g	**1**
Merlin	*Falco columbarius*	Raptors <300g	**1**
Eurasian Hobby	*Falco subbuteo*	Raptors <300g	**1**
Swallow-tailed Kite	*Elanoides forficatus*	Raptors 300-999g	**2**
White-tailed Kite	*Elanus leucurus*	Raptors 300-999g	**2**
Snail Kite	*Rostrhamus sociabilis*	Raptors 300-999g	**2**
Double-toothed Kite	*Harpagus bidentatus*	Raptors 300-999g	**2**
Black Kite	*Milvus migrans*	Raptors 300-999g	**2**
Northern Harrier	*Circus cyaneus*	Raptors 300-999g	**2**
Cooper's Hawk	*Accipiter cooperii*	Raptors 300-999g	**2**
Northern Goshawk	*Accipiter gentilis*	Raptors 300-999g	**2**
Crane Hawk	*Geranospiza caerulescens*	Raptors 300-999g	**2**
Common Black Hawk	*Buteogallus anthracinus*	Raptors 300-999g	**2**
Great Black Hawk	*Buteogallus urubitinga*	Raptors 300-999g	**2**
Harris's Hawk	*Parabuteo unicinctus*	Raptors 300-999g	**2**
White-tailed Hawk	*Geranoaetus albicaudatus*	Raptors 300-999g	**2**
Roadside Hawk	*Buteo magnirostris*	Raptors 300-999g	**2**
Red-shouldered Hawk	*Buteo lineatus*	Raptors 300-999g	**2**
Broad-winged Hawk	*Buteo platypterus*	Raptors 300-999g	**2**
Gray Hawk	*Buteo plagiatus*	Raptors 300-999g	**2**
Gray-lined Hawk	*Buteo nitidus*	Raptors 300-999g	**2**
Short-tailed Hawk	*Buteo brachyurus*	Raptors 300-999g	**2**
Swainson's Hawk	*Buteo swainsoni*	Raptors 300-999g	**2**
Zone-tailed Hawk	*Buteo albonotatus*	Raptors 300-999g	**2**
Hawaiian Hawk	*Buteo solitarius*	Raptors 300-999g	**2**
Red-tailed Hawk	*Buteo jamaicensis*	Raptors 300-999g	**2**
Common Buzzard	*Buteo buteo*	Raptors 300-999g	**2**
Barn Owl	*Tyto alba*	Raptors 300-999g	**2**
Northern Hawk Owl	*Surnia ulula*	Raptors 300-999g	**2**
Mottled Owl	*Ciccaba virgata*	Raptors 300-999g	**2**

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Raptors/Vultures/Owls (Continued)			
Common Name	**Scientific Name**	**Guild (Mass)**	**Severity**
Spotted Owl	*Strix occidentalis*	Raptors 300-999g	**2**
Barred Owl	*Strix varia*	Raptors 300-999g	**2**
Short-eared Owl	*Asio flammeus*	Raptors 300-999g	**2**
Collared Forest-Falcon	*Micrastur semitorquatus*	Raptors 300-999g	**2**
Red-footed Falcon	*Falco vespertinus*	Raptors 300-999g	**2**
Aplomado Falcon	*Falco femoralis*	Raptors 300-999g	**2**
Peregrine Falcon	*Falco peregrinus*	Raptors 300-999g	**2**
Prairie Falcon	*Falco mexicanus*	Raptors 300-999g	**2**
Turkey Vulture	*Cathartes aura*	Raptors 1000-1999g	**3**
Osprey	*Pandion haliaetus*	Raptors 1000-1999g	**3**
White-tailed Hawk	*Buteo albicaudatus*	Raptors 1000-1999g	**3**
Ferruginous Hawk	*Buteo regalis*	Raptors 1000-1999g	**3**
Rough-legged Hawk	*Buteo lagopus*	Raptors 1000-1999g	**3**
Spectacled Owl	*Pulsatrix perspicillata*	Raptors 1000-1999g	**3**
Great Horned Owl	*Bubo virginianus*	Raptors 1000-1999g	**3**
Snowy Owl	*Bubo scandiacus*	Raptors 1000-1999g	**3**
Crested Caracara	*Caracara cheriway*	Raptors 1000-1999g	**3**
Gyrfalcon	*Falco rusticolus*	Raptors 1000-1999g	**3**
Black Vulture	*Coragyps atratus*	Raptors 2000-3999g	**4**
California Condor	*Gymnogyps californianus*	Raptors >4000g	**5**
Bald Eagle	*Haliaeetus leucocephalus*	Raptors >4000g	**5**
White-tailed Eagle	*Haliaeetus albicilla*	Raptors >4000g	**5**
Steller's Sea-Eagle	*Haliaeetus pelagicus*	Raptors >4000g	**5**
Golden Eagle	*Aquila chrysaetos*	Raptors >4000g	**5**
Upland Game Birds			
Common Name	**Scientific Name**	**Guild (Mass)**	**Severity**
Mountain Quail	*Oreortyx pictus*	Upland Game Birds <300g	**1**
Scaled Quail	*Callipepla squamata*	Upland Game Birds <300g	**1**
California Quail	*Callipepla californica*	Upland Game Birds <300g	**1**
Gambel's Quail	*Callipepla gambelii*	Upland Game Birds <300g	**1**
Northern Bobwhite	*Colinus virginianus*	Upland Game Birds <300g	**1**

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Upland Game Birds (Continued)			
Common Name	**Scientific Name**	**Guild (Mass)**	**Severity**
Montezuma Quail	*Cyrtonyx montezumae*	Upland Game Birds <300g	**1**
Gray Francolin	*Francolinus pondicerianus*	Upland Game Birds <300g	**1**
Chinese Bamboo-Partridge	*Bambusicola thoracicus*	Upland Game Birds <300g	**1**
Plain Chachalaca	*Ortalis vetula*	Upland Game Birds 300-999g	**2**
Chukar	*Alectoris chukar*	Upland Game Birds 300-999g	**2**
Black Francolin	*Francolinus francolinus*	Upland Game Birds 300-999g	**2**
Gray Partridge	*Perdix perdix*	Upland Game Birds 300-999g	**2**
Red Junglefowl	*Gallus gallus*	Upland Game Birds 300-999g	**2**
Lady Amherst's Pheasant	*Chrysolophus amherstiae*	Upland Game Birds 300-999g	**2**
Ruffed Grouse	*Bonasa umbellus*	Upland Game Birds 300-999g	**2**
Willow Ptarmigan	*Lagopus lagopus*	Upland Game Birds 300-999g	**2**
Rock Ptarmigan	*Lagopus muta*	Upland Game Birds 300-999g	**2**
White-tailed Ptarmigan	*Lagopus leucura*	Upland Game Birds 300-999g	**2**
Dusky Grouse	*Dendragapus obscurus*	Upland Game Birds 300-999g	**2**
Sooty Grouse	*Dendragapus fuliginosus*	Upland Game Birds 300-999g	**2**
Sharp-tailed Grouse	*Tympanuchus phasianellus*	Upland Game Birds 300-999g	**2**
Greater Prairie-Chicken	*Tympanuchus cupido*	Upland Game Birds 300-999g	**2**
Lesser Prairie-Chicken	*Tympanuchus pallidicinctus*	Upland Game Birds 300-999g	**2**
Spruce Grouse	*Falcipennis canadensis*	Upland Game Birds 300-999g	**2**
Helmeted Guineafowl	*Numida meleagris*	Upland Game Birds 1000-1999g	**3**
Himalayan Snowcock	*Tetraogallus himalayensis*	Upland Game Birds 1000-1999g	**3**
Erckel's Francolin	*Francolinus erckelii*	Upland Game Birds 1000-1999g	**3**

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Upland Game Birds (Continued)			
Common Name	**Scientific Name**	**Guild (Mass)**	**Severity**
Kalij Pheasant	*Lophura leucomelanos*	Upland Game Birds 1000-1999g	**3**
Silver Pheasant	*Lophura nycthemera*	Upland Game Birds 1000-1999g	**3**
Elliot's Pheasant	*Syrmaticus ellioti*	Upland Game Birds 1000-1999g	**3**
Ring-necked Pheasant	*Phasianus colchicus*	Upland Game Birds 1000-1999g	**3**
Greater Sage-Grouse	*Centrocercus urophasianus*	Upland Game Birds 2000-3999g	**4**
Gunnison Sage-Grouse	*Centrocercus minimus*	Upland Game Birds 2000-3999g	**4**
Indian Peafowl	*Pavo cristatus*	Upland Game Birds >4000g	**5**
Wild Turkey	*Meleagris gallopavo*	Upland Game Birds >4000g	**5**
Cranes			
Common Name	**Scientific Name**	**Guild (Mass)**	**Severity**
Gray Crowned Crane	*Balearica regulorum*	Cranes >4000g	**5**
Sandhill Crane	*Grus canadensis*	Cranes >4000g	**5**
Sarus Crane	*Grus antigone*	Cranes >4000g	**5**
Common Crane	*Grus grus*	Cranes >4000g	**5**
Hooded Crane	*Grus monacha*	Cranes >4000g	**5**
Whooping Crane	*Grus americana*	Cranes >4000g	**5**
Shorebirds			
		If Flocks < 20	**4**
		If Flocks ≥ 20	**5**
Common Name	**Scientific Name**	**Guild (Mass)**	**Severity**
Double-striped Thick-knee	*Burhinus bistriatus*	Shorebirds <300g	**1**
Black-winged Stilt	*Himantopus himantopus*	Shorebirds <300g	**1**
Black-necked Stilt	*Himantopus mexicanus*	Shorebirds <300g	**1**
Northern Lapwing	*Vanellus vanellus*	Shorebirds <300g	**1**
Sociable Lapwing	*Vanellus gregarius*	Shorebirds <300g	**1**
Black-bellied Plover	*Pluvialis squatarola*	Shorebirds <300g	**1**
European Golden-Plover	*Pluvialis apricaria*	Shorebirds <300g	**1**
American Golden-Plover	*Pluvialis dominica*	Shorebirds <300g	**1**
Pacific Golden-Plover	*Pluvialis fulva*	Shorebirds <300g	**1**
Lesser Sand-Plover	*Charadrius mongolus*	Shorebirds <300g	**1**
Greater Sand-Plover	*Charadrius leschenaultii*	Shorebirds <300g	**1**
Collared Plover	*Charadrius collaris*	Shorebirds <300g	**1**

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Shorebirds (Continued)			
		If Flocks < 20	4
		If Flocks ≥ 20	5
Common Name	**Scientific Name**	**Guild (Mass)**	**Severity**
Snowy Plover	*Charadrius nivosus*	Shorebirds <300g	1
Wilson's Plover	*Charadrius wilsonia*	Shorebirds <300g	1
Common Ringed Plover	*Charadrius hiaticula*	Shorebirds <300g	1
Semipalmated Plover	*Charadrius semipalmatus*	Shorebirds <300g	1
Piping Plover	*Charadrius melodus*	Shorebirds <300g	1
Little Ringed Plover	*Charadrius dubius*	Shorebirds <300g	1
Killdeer	*Charadrius vociferus*	Shorebirds <300g	1
Mountain Plover	*Charadrius montanus*	Shorebirds <300g	1
Eurasian Dotterel	*Charadrius morinellus*	Shorebirds <300g	1
Northern Jacana	*Jacana spinosa*	Shorebirds <300g	1
Terek Sandpiper	*Xenus cinereus*	Shorebirds <300g	1
Common Sandpiper	*Actitis hypoleucos*	Shorebirds <300g	1
Spotted Sandpiper	*Actitis macularius*	Shorebirds <300g	1
Green Sandpiper	*Tringa ochropus*	Shorebirds <300g	1
Solitary Sandpiper	*Tringa solitaria*	Shorebirds <300g	1
Gray-tailed Tattler	*Tringa brevipes*	Shorebirds <300g	1
Wandering Tattler	*Tringa incana*	Shorebirds <300g	1
Spotted Redshank	*Tringa erythropus*	Shorebirds <300g	1
Greater Yellowlegs	*Tringa melanoleuca*	Shorebirds <300g	1
Common Greenshank	*Tringa nebularia*	Shorebirds <300g	1
Willet	*Tringa semipalmata*	Shorebirds <300g	1
Lesser Yellowlegs	*Tringa flavipes*	Shorebirds <300g	1
Marsh Sandpiper	*Tringa stagnatilis*	Shorebirds <300g	1
Wood Sandpiper	*Tringa glareola*	Shorebirds <300g	1
Common Redshank	*Tringa totanus*	Shorebirds <300g	1
Upland Sandpiper	*Bartramia longicauda*	Shorebirds <300g	1
Whimbrel	*Numenius phaeopus*	Shorebirds <300g	1
Ruddy Turnstone	*Arenaria interpres*	Shorebirds <300g	1
Black Turnstone	*Arenaria melanocephala*	Shorebirds <300g	1
Great Knot	*Calidris tenuirostris*	Shorebirds <300g	1
Red Knot	*Calidris canutus*	Shorebirds <300g	1
Surfbird	*Calidris virgata*	Shorebirds <300g	1
Ruff	*Calidris pugnax*	Shorebirds <300g	1
Broad-billed Sandpiper	*Calidris falcinellus*	Shorebirds <300g	1
Sharp-tailed Sandpiper	*Calidris acuminata*	Shorebirds <300g	1
Stilt Sandpiper	*Calidris himantopus*	Shorebirds <300g	1
Curlew Sandpiper	*Calidris ferruginea*	Shorebirds <300g	1

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Shorebirds (Continued)			
		If Flocks < 20	**4**
		If Flocks ≥ 20	**5**
Common Name	**Scientific Name**	**Guild (Mass)**	**Severity**
Temminck's Stint	*Calidris temminckii*	Shorebirds <300g	**1**
Long-toed Stint	*Calidris subminuta*	Shorebirds <300g	**1**
Spoon-billed Sandpiper	*Calidris pygmea*	Shorebirds <300g	**1**
Red-necked Stint	*Calidris ruficollis*	Shorebirds <300g	**1**
Sanderling	*Calidris alba*	Shorebirds <300g	**1**
Dunlin	*Calidris alpina*	Shorebirds <300g	**1**
Rock Sandpiper	*Calidris ptilocnemis*	Shorebirds <300g	**1**
Purple Sandpiper	*Calidris maritima*	Shorebirds <300g	**1**
Baird's Sandpiper	*Calidris bairdii*	Shorebirds <300g	**1**
Little Stint	*Calidris minuta*	Shorebirds <300g	**1**
Least Sandpiper	*Calidris minutilla*	Shorebirds <300g	**1**
White-rumped Sandpiper	*Calidris fuscicollis*	Shorebirds <300g	**1**
Buff-breasted Sandpiper	*Calidris subruficollis*	Shorebirds <300g	**1**
Pectoral Sandpiper	*Calidris melanotos*	Shorebirds <300g	**1**
Semipalmated Sandpiper	*Calidris pusilla*	Shorebirds <300g	**1**
Western Sandpiper	*Calidris mauri*	Shorebirds <300g	**1**
Short-billed Dowitcher	*Limnodromus griseus*	Shorebirds <300g	**1**
Long-billed Dowitcher	*Limnodromus scolopaceus*	Shorebirds <300g	**1**
Jack Snipe	*Lymnocryptes minimus*	Shorebirds <300g	**1**
Wilson's Snipe	*Gallinago delicata*	Shorebirds <300g	**1**
Common Snipe	*Gallinago gallinago*	Shorebirds <300g	**1**
Pin-tailed Snipe	*Gallinago stenura*	Shorebirds <300g	**1**
Solitary Snipe	*Gallinago solitaria*	Shorebirds <300g	**1**
Eurasian Woodcock	*Scolopax rusticola*	Shorebirds <300g	**1**
American Woodcock	*Scolopax minor*	Shorebirds <300g	**1**
Wilson's Phalarope	*Phalaropus tricolor*	Shorebirds <300g	**1**
Red-necked Phalarope	*Phalaropus lobatus*	Shorebirds <300g	**1**
Red Phalarope	*Phalaropus fulicarius*	Shorebirds <300g	**1**
Oriental Pratincole	*Glareola maldivarum*	Shorebirds <300g	**1**
American Avocet	*Recurvirostra americana*	Shorebirds 300-999g	**2**
Eurasian Oystercatcher	*Haematopus ostralegus*	Shorebirds 300-999g	**2**
American Oystercatcher	*Haematopus palliatus*	Shorebirds 300-999g	**2**
Black Oystercatcher	*Haematopus bachmani*	Shorebirds 300-999g	**2**
Little Curlew	*Numenius minutus*	Shorebirds 300-999g	**2**
Eskimo Curlew	*Numenius borealis*	Shorebirds 300-999g	**2**
Bristle-thighed Curlew	*Numenius tahitiensis*	Shorebirds 300-999g	**2**

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Shorebirds (Continued)			
		If Flocks < 20	**4**
		If Flocks ≥ 20	**5**
Common Name	**Scientific Name**	**Guild (Mass)**	**Severity**
Far Eastern Curlew	*Numenius madagascariensis*	Shorebirds 300-999g	**2**
Slender-billed Curlew	*Numenius tenuirostris*	Shorebirds 300-999g	**2**
Eurasian Curlew	*Numenius arquata*	Shorebirds 300-999g	**2**
Long-billed Curlew	*Numenius americanus*	Shorebirds 300-999g	**2**
Black-tailed Godwit	*Limosa limosa*	Shorebirds 300-999g	**2**
Hudsonian Godwit	*Limosa haemastica*	Shorebirds 300-999g	**2**
Bar-tailed Godwit	*Limosa lapponica*	Shorebirds 300-999g	**2**
Marbled Godwit	*Limosa fedoa*	Shorebirds 300-999g	**2**
Gulls/Terns			
		If Flocks < 10	**4**
		If Flocks ≥ 10	**5**
Common Name	**Scientific Name**	**Guild (Mass)**	**Severity**
Swallow-tailed Gull	*Creagrus furcatus*	Gulls/Terns <300g	**1**
Black-legged Kittiwake	*Rissa tridactyla*	Gulls/Terns <300g	**1**
Red-legged Kittiwake	*Rissa brevirostris*	Gulls/Terns <300g	**1**
Ivory Gull	*Pagophila eburnea*	Gulls/Terns <300g	**1**
Sabine's Gull	*Xema sabini*	Gulls/Terns <300g	**1**
Bonaparte's Gull	*Chroicocephalus philadelphia*	Gulls/Terns <300g	**1**
Little Gull	*Hydrocoloeus minutus*	Gulls/Terns <300g	**1**
Ross's Gull	*Rhodostethia rosea*	Gulls/Terns <300g	**1**
Laughing Gull	*Leucophaeus atricilla*	Gulls/Terns <300g	**1**
Brown Noddy	*Anous stolidus*	Gulls/Terns <300g	**1**
Black Noddy	*Anous minutus*	Gulls/Terns <300g	**1**
Blue-gray Noddy	*Procelsterna cerulea*	Gulls/Terns <300g	**1**
White Tern	*Gygis alba*	Gulls/Terns <300g	**1**
Sooty Tern	*Onychoprion fuscatus*	Gulls/Terns <300g	**1**
Gray-backed Tern	*Onychoprion lunatus*	Gulls/Terns <300g	**1**
Bridled Tern	*Onychoprion anaethetus*	Gulls/Terns <300g	**1**
Aleutian Tern	*Onychoprion aleuticus*	Gulls/Terns <300g	**1**
Little Tern	*Sternula albifrons*	Gulls/Terns <300g	**1**
Least Tern	*Sternula antillarum*	Gulls/Terns <300g	**1**
Large-billed Tern	*Phaetusa simplex*	Gulls/Terns <300g	**1**
Gull-billed Tern	*Gelochelidon nilotica*	Gulls/Terns <300g	**1**
Black Tern	*Chlidonias niger*	Gulls/Terns <300g	**1**
White-winged Tern	*Chlidonias leucopterus*	Gulls/Terns <300g	**1**

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Gulls/Terns (Continued)			
		If Flocks < 10	4
		If Flocks ≥ 10	5
Common Name	**Scientific Name**	**Guild (Mass)**	**Severity**
Whiskered Tern	*Chlidonias hybrida*	Gulls/Terns <300g	1
Roseate Tern	*Sterna dougallii*	Gulls/Terns <300g	1
Common Tern	*Sterna hirundo*	Gulls/Terns <300g	1
Arctic Tern	*Sterna paradisaea*	Gulls/Terns <300g	1
Forster's Tern	*Sterna forsteri*	Gulls/Terns <300g	1
Great Crested Tern	*Thalasseus bergii*	Gulls/Terns <300g	1
Sandwich Tern	*Thalasseus sandvicensis*	Gulls/Terns <300g	1
Elegant Tern	*Thalasseus elegans*	Gulls/Terns <300g	1
Black-headed Gull	*Chroicocephalus ridibundus*	Gulls/Terns 300-999g	2
Franklin's Gull	*Leucophaeus pipixcan*	Gulls/Terns 300-999g	2
Belcher's Gull	*Larus belcheri*	Gulls/Terns 300-999g	2
Black-tailed Gull	*Larus crassirostris*	Gulls/Terns 300-999g	2
Heermann's Gull	*Larus heermanni*	Gulls/Terns 300-999g	2
Mew Gull	*Larus canus*	Gulls/Terns 300-999g	2
Ring-billed Gull	*Larus delawarensis*	Gulls/Terns 300-999g	2
California Gull	*Larus californicus*	Gulls/Terns 300-999g	2
Iceland Gull	*Larus glaucoides*	Gulls/Terns 300-999g	2
Lesser Black-backed Gull	*Larus fuscus*	Gulls/Terns 300-999g	2
Caspian Tern	*Hydroprogne caspia*	Gulls/Terns 300-999g	2
Royal Tern	*Thalasseus maximus*	Gulls/Terns 300-999g	2
Black Skimmer	*Rynchops niger*	Gulls/Terns 300-999g	2
Western Gull	*Larus occidentalis*	Gulls/Terns 1000-1999g	3
Yellow-footed Gull	*Larus livens*	Gulls/Terns 1000-1999g	3
Herring Gull	*Larus argentatus*	Gulls/Terns 1000-1999g	3
Yellow-legged Gull	*Larus michahellis*	Gulls/Terns 1000-1999g	3
Thayer's Gull	*Larus thayeri*	Gulls/Terns 1000-1999g	3
Slaty-backed Gull	*Larus schistisagus*	Gulls/Terns 1000-1999g	3
Glaucous-winged Gull	*Larus glaucescens*	Gulls/Terns 1000-1999g	3
Glaucous Gull	*Larus hyperboreus*	Gulls/Terns 1000-1999g	3
Great Black-backed Gull	*Larus marinus*	Gulls/Terns 1000-1999g	3
Kelp Gull	*Larus dominicanus*	Gulls/Terns 1000-1999g	3

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Pigeons/Doves			
		If Flocks < 20	**4**
		If Flocks ≥ 20	**5**
Common Name	**Scientific Name**	**Guild (Mass)**	**Severity**
Chestnut-bellied Sandgrouse	*Pterocles exustus*	Pigeons/Doves <300g	**1**
Rock Pigeon	*Columba livia*	Pigeons/Doves <300g	**1**
Scaly-naped Pigeon	*Patagioenas squamosa*	Pigeons/Doves <300g	**1**
White-crowned Pigeon	*Patagioenas leucocephala*	Pigeons/Doves <300g	**1**
Red-billed Pigeon	*Patagioenas flavirostris*	Pigeons/Doves <300g	**1**
Oriental Turtle-Dove	*Streptopelia orientalis*	Pigeons/Doves <300g	**1**
African Collared-Dove	*Streptopelia roseogrisea*	Pigeons/Doves <300g	**1**
European Turtle-Dove	*Streptopelia turtur*	Pigeons/Doves <300g	**1**
Eurasian Collared-Dove	*Streptopelia decaocto*	Pigeons/Doves <300g	**1**
Spotted Dove	*Streptopelia chinensis*	Pigeons/Doves <300g	**1**
Laughing Dove	*Streptopelia senegalensis*	Pigeons/Doves <300g	**1**
Zebra Dove	*Geopelia striata*	Pigeons/Doves <300g	**1**
Inca Dove	*Columbina inca*	Pigeons/Doves <300g	**1**
Common Ground-Dove	*Columbina passerina*	Pigeons/Doves <300g	**1**
Ruddy Ground-Dove	*Columbina talpacoti*	Pigeons/Doves <300g	**1**
Ruddy Quail-Dove	*Geotrygon montana*	Pigeons/Doves <300g	**1**
Key West Quail-Dove	*Geotrygon chrysia*	Pigeons/Doves <300g	**1**
White-tipped Dove	*Leptotila verreauxi*	Pigeons/Doves <300g	**1**
White-winged Dove	*Zenaida asiatica*	Pigeons/Doves <300g	**1**
Zenaida Dove	*Zenaida aurita*	Pigeons/Doves <300g	**1**
Mourning Dove	*Zenaida macroura*	Pigeons/Doves <300g	**1**
Band-tailed Pigeon	*Patagioenas fasciata*	Pigeons/Doves 300-999g	**2**
Parrots			
Common Name	**Scientific Name**	**Guild (Mass)**	**Severity**
Galah	*Eolophus roseicapilla*	Parrots <300g	**1**
Tanimbar corella	*Cacatua goffiniana*	Parrots <300g	**1**
Sulphur-crested Cockatoo	*Cacatua galerita*	Parrots <300g	**1**
Salmon-crested Cockatoo	*Cacutua moluccensis*	Parrots <300g	**1**
Rose-ringed Parakeet	*Psittacula krameri*	Parrots <300g	**1**
Plum-headed Parakeet	*Psittacula cyanocephala*	Parrots <300g	**1**
Blossom-headed Parakeet	*Psittacula roseata*	Parrots <300g	**1**
Pale-headed Rosella	*Platycercus adscitus*	Parrots <300g	**1**
Budgerigar	*Melopsittacus undulatus*	Parrots <300g	**1**
Chattering Lory	*Lorius garrulus*	Parrots <300g	**1**

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Parrots (Continued)			
Common Name	**Scientific Name**	**Guild (Mass)**	**Severity**
Rainbow Lorikeet	*Trichoglossus haematodus*	Parrots <300g	**1**
Scaly-breasted Lorikeet	*Trichoglossus chlorolepidotus*	Parrots <300g	**1**
Rosy-faced Lovebird	*Agapornis roseicollis*	Parrots <300g	**1**
Fischer's Lovebird	*Agapornis fischeri*	Parrots <300g	**1**
Yellow-collared Lovebird	*Agapornis personatus*	Parrots <300g	**1**
Monk Parakeet	*Myiopsitta monachus*	Parrots <300g	**1**
Tuui Parakeet	*Brotogeris sanctithomae*	Parrots <300g	**1**
White-winged Parakeet	*Brotogeris versicolurus*	Parrots <300g	**1**
Yellow-chevroned Parakeet	*Brotogeris chiriri*	Parrots <300g	**1**
Orange-chinned Parakeet	*Brotogeris jugularis*	Parrots <300g	**1**
Maroon-bellied Parakeet	*Pyrrhura frontalis*	Parrots <300g	**1**
Green-cheeked Parakeet	*Pyrrhura molinae*	Parrots <300g	**1**
Burrowing Parakeet	*Cyanoliseus patagonus*	Parrots <300g	**1**
Orange-fronted Parakeet	*Eupsittula canicularis*	Parrots <300g	**1**
Peach-fronted Parakeet	*Eupsittula aurea*	Parrots <300g	**1**
Brown-throated Parakeet	*Eupsittula pertinax*	Parrots <300g	**1**
Dusky-headed Parakeet	*Aratinga weddellii*	Parrots <300g	**1**
Nanday Parakeet	*Aratinga nenday*	Parrots <300g	**1**
Blue-crowned Parakeet	*Thectocercus acuticaudatus*	Parrots <300g	**1**
Crimson-fronted Parakeet	*Psittacara finschi*	Parrots <300g	**1**
Scarlet-fronted Parakeet	*Psittacara wagleri*	Parrots <300g	**1**
Mitred Parakeet	*Psittacara mitratus*	Parrots <300g	**1**
Red-masked Parakeet	*Psittacara erythrogenys*	Parrots <300g	**1**
White-eyed Parakeet	*Psittacara leucophthalmus*	Parrots <300g	**1**
Eclectus Parrot	*Eclectus roratus*	Parrots 300-999g	**2**
Alexandrine Parakeet	*Psittacula eupatria*	Parrots 300-999g	**2**
Gray Parrot	*Psittacus erithacus*	Parrots 300-999g	**2**
Rueppell's Parrot	*Poicephalus rueppellii*	Parrots 300-999g	**2**
Senegal Parrot	*Poicephalus senegalus*	Parrots 300-999g	**2**
White-crowned Parrot	*Pionus senilis*	Parrots 300-999g	**2**
Festive Parrot	*Amazona festiva*	Parrots 300-999g	**2**
Red-spectacled Parrot	*Amazona pretrei*	Parrots 300-999g	**2**
Red-crowned Parrot	*Amazona viridigenalis*	Parrots 300-999g	**2**
Lilac-crowned Parrot	*Amazona finschi*	Parrots 300-999g	**2**
Red-lored Parrot	*Amazona autumnalis*	Parrots 300-999g	**2**
Yellow-headed Parrot	*Amazona oratrix*	Parrots 300-999g	**2**

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Parrots (Continued)			
Common Name	**Scientific Name**	**Guild (Mass)**	**Severity**
Yellow-shouldered Parrot	*Amazona barbadensis*	Parrots 300-999g	**2**
Turquoise-fronted Parrot	*Amazona aestiva*	Parrots 300-999g	**2**
White-fronted Parrot	*Amazona albifrons*	Parrots 300-999g	**2**
Hispaniolan Parrot	*Amazona ventralis*	Parrots 300-999g	**2**
Mealy Parrot	*Amazona farinosa*	Parrots 300-999g	**2**
Orange-winged Parrot	*Amazona amazonica*	Parrots 300-999g	**2**
Thick-billed Parrot	*Rhynchopsitta pachyrhyncha*	Parrots 300-999g	**2**
Maroon-fronted Parrot	*Rhynchopsitta terrisi*	Parrots 300-999g	**2**
Chestnut-fronted Macaw	*Ara severus*	Parrots 300-999g	**2**
Yellow-collared Macaw	*Primolius auricollis*	Parrots 300-999g	**2**
Red-shouldered Macaw	*Diopsittaca nobilis*	Parrots 300-999g	**2**
Hyacinth Macaw	*Anodorhynchus hyacinthinus*	Parrots 1000-3999g	**3**
Blue-and-yellow Macaw	*Ara ararauna*	Parrots 1000-3999g	**3**
Military Macaw	*Ara militaris*	Parrots 1000-3999g	**3**
Scarlet Macaw	*Ara macao*	Parrots 1000-3999g	**3**
Aerial Foragers			
Common Name	**Scientific Name**	**Guild (Mass)**	**Severity**
Lesser Nighthawk	*Chordeiles acutipennis*	Aerial Foragers <300g	**1**
Common Nighthawk	*Chordeiles minor*	Aerial Foragers <300g	**1**
Antillean Nighthawk	*Chordeiles gundlachii*	Aerial Foragers <300g	**1**
Common Pauraque	*Nyctidromus albicollis*	Aerial Foragers <300g	**1**
Common Poorwill	*Phalaenoptilus nuttallii*	Aerial Foragers <300g	**1**
Chuck-will's-widow	*Antrostomus carolinensis*	Aerial Foragers <300g	**1**
Buff-collared Nightjar	*Antrostomus ridgwayi*	Aerial Foragers <300g	**1**
Eastern Whip-poor-will	*Antrostomus vociferus*	Aerial Foragers <300g	**1**
Mexican Whip-poor-will	*Antrostomus arizonae*	Aerial Foragers <300g	**1**
Gray Nightjar	*Caprimulgus jotaka*	Aerial Foragers <300g	**1**
Black Swift	*Cypseloides niger*	Aerial Foragers <300g	**1**
Chimney Swift	*Chaetura pelagica*	Aerial Foragers <300g	**1**
Vaux's Swift	*Chaetura vauxi*	Aerial Foragers <300g	**1**
White-throated Needletail	*Hirundapus caudacutus*	Aerial Foragers <300g	**1**
Mariana Swiftlet	*Aerodramus bartschi*	Aerial Foragers <300g	**1**
White-nest Swiftlet	*Aerodramus fuciphagus*	Aerial Foragers <300g	**1**
Common Swift	*Apus apus*	Aerial Foragers <300g	**1**
Pacific Swift	*Apus pacificus*	Aerial Foragers <300g	**1**
White-throated Swift	*Aeronautes saxatalis*	Aerial Foragers <300g	**1**
Purple Martin	*Progne subis*	Aerial Foragers <300g	**1**

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Aerial Foragers (Continued)			
Common Name	**Scientific Name**	**Guild (Mass)**	**Severity**
Cuban Martin	*Progne cryptoleuca*	Aerial Foragers <300g	**1**
Gray-breasted Martin	*Progne chalybea*	Aerial Foragers <300g	**1**
Southern Martin	*Progne elegans*	Aerial Foragers <300g	**1**
Brown-chested Martin	*Progne tapera*	Aerial Foragers <300g	**1**
Tree Swallow	*Tachycineta bicolor*	Aerial Foragers <300g	**1**
Mangrove Swallow	*Tachycineta albilinea*	Aerial Foragers <300g	**1**
Violet-green Swallow	*Tachycineta thalassina*	Aerial Foragers <300g	**1**
Bahama Swallow	*Tachycineta cyaneoviridis*	Aerial Foragers <300g	**1**
Northern Rough-winged Swallow	*Stelgidopteryx serripennis*	Aerial Foragers <300g	**1**
Bank Swallow	*Riparia riparia*	Aerial Foragers <300g	**1**
Cliff Swallow	*Petrochelidon pyrrhonota*	Aerial Foragers <300g	**1**
Cave Swallow	*Petrochelidon fulva*	Aerial Foragers <300g	**1**
Barn Swallow	*Hirundo rustica*	Aerial Foragers <300g	**1**
Common House-Martin	*Delichon urbicum*	Aerial Foragers <300g	**1**
Woodland Birds			
Common Name	**Scientific Name**	**Guild (Mass)**	**Severity**
Common Cuckoo	*Cuculus canorus*	Woodland Birds <300g	**1**
Oriental Cuckoo	*Cuculus optatus*	Woodland Birds <300g	**1**
Dark-billed Cuckoo	*Coccyzus melacoryphus*	Woodland Birds <300g	**1**
Yellow-billed Cuckoo	*Coccyzus americanus*	Woodland Birds <300g	**1**
Mangrove Cuckoo	*Coccyzus minor*	Woodland Birds <300g	**1**
Black-billed Cuckoo	*Coccyzus erythropthalmus*	Woodland Birds <300g	**1**
Smooth-billed Ani	*Crotophaga ani*	Woodland Birds <300g	**1**
Groove-billed Ani	*Crotophaga sulcirostris*	Woodland Birds <300g	**1**
Green Violetear	*Colibri thalassinus*	Woodland Birds <300g	**1**
Green-breasted Mango	*Anthracothorax prevostii*	Woodland Birds <300g	**1**
Magnificent Hummingbird	*Eugenes fulgens*	Woodland Birds <300g	**1**
Plain-capped Starthroat	*Heliomaster constantii*	Woodland Birds <300g	**1**
Blue-throated Hummingbird	*Lampornis clemenciae*	Woodland Birds <300g	**1**
Bahama Woodstar	*Calliphlox evelynae*	Woodland Birds <300g	**1**
Lucifer Hummingbird	*Calothorax lucifer*	Woodland Birds <300g	**1**
Ruby-throated Hummingbird	*Archilochus colubris*	Woodland Birds <300g	**1**
Black-chinned Hummingbird	*Archilochus alexandri*	Woodland Birds <300g	**1**
Anna's Hummingbird	*Calypte anna*	Woodland Birds <300g	**1**
Costa's Hummingbird	*Calypte costae*	Woodland Birds <300g	**1**
Bumblebee Hummingbird	*Atthis heloisa*	Woodland Birds <300g	**1**

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Woodland Birds (Continued)			
Common Name	**Scientific Name**	**Guild (Mass)**	**Severity**
Broad-tailed Hummingbird	*Selasphorus platycercus*	Woodland Birds <300g	**1**
Rufous Hummingbird	*Selasphorus rufus*	Woodland Birds <300g	**1**
Allen's Hummingbird	*Selasphorus sasin*	Woodland Birds <300g	**1**
Calliope Hummingbird	*Selasphorus calliope*	Woodland Birds <300g	**1**
Broad-billed Hummingbird	*Cynanthus latirostris*	Woodland Birds <300g	**1**
Berylline Hummingbird	*Amazilia beryllina*	Woodland Birds <300g	**1**
Buff-bellied Hummingbird	*Amazilia yucatanensis*	Woodland Birds <300g	**1**
Cinnamon Hummingbird	*Amazilia rutila*	Woodland Birds <300g	**1**
Violet-crowned Hummingbird	*Amazilia violiceps*	Woodland Birds <300g	**1**
White-eared Hummingbird	*Hylocharis leucotis*	Woodland Birds <300g	**1**
Xantus's Hummingbird	*Hylocharis xantusii*	Woodland Birds <300g	**1**
Elegant Trogon	*Trogon elegans*	Woodland Birds <300g	**1**
Eared Quetzal	*Euptilotis neoxenus*	Woodland Birds <300g	**1**
Eurasian Hoopoe	*Upupa epops*	Woodland Birds <300g	**1**
Eurasian Wryneck	*Jynx torquilla*	Woodland Birds <300g	**1**
Lewis's Woodpecker	*Melanerpes lewis*	Woodland Birds <300g	**1**
Red-headed Woodpecker	*Melanerpes erythrocephalus*	Woodland Birds <300g	**1**
Acorn Woodpecker	*Melanerpes formicivorus*	Woodland Birds <300g	**1**
Gila Woodpecker	*Melanerpes uropygialis*	Woodland Birds <300g	**1**
Golden-fronted Woodpecker	*Melanerpes aurifrons*	Woodland Birds <300g	**1**
Red-bellied Woodpecker	*Melanerpes carolinus*	Woodland Birds <300g	**1**
Williamson's Sapsucker	*Sphyrapicus thyroideus*	Woodland Birds <300g	**1**
Yellow-bellied Sapsucker	*Sphyrapicus varius*	Woodland Birds <300g	**1**
Red-naped Sapsucker	*Sphyrapicus nuchalis*	Woodland Birds <300g	**1**
Red-breasted Sapsucker	*Sphyrapicus ruber*	Woodland Birds <300g	**1**
Great Spotted Woodpecker	*Dendrocopos major*	Woodland Birds <300g	**1**
Ladder-backed Woodpecker	*Picoides scalaris*	Woodland Birds <300g	**1**
Nuttall's Woodpecker	*Picoides nuttallii*	Woodland Birds <300g	**1**
Downy Woodpecker	*Picoides pubescens*	Woodland Birds <300g	**1**
Hairy Woodpecker	*Picoides villosus*	Woodland Birds <300g	**1**
Arizona Woodpecker	*Picoides arizonae*	Woodland Birds <300g	**1**
Red-cockaded Woodpecker	*Picoides borealis*	Woodland Birds <300g	**1**
White-headed Woodpecker	*Picoides albolarvatus*	Woodland Birds <300g	**1**
American Three-toed Woodpecker	*Picoides dorsalis*	Woodland Birds <300g	**1**
Black-backed Woodpecker	*Picoides arcticus*	Woodland Birds <300g	**1**

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Woodland Birds (Continued)			
Common Name	**Scientific Name**	**Guild (Mass)**	**Severity**
Northern Flicker	*Colaptes auratus*	Woodland Birds <300g	**1**
Gilded Flicker	*Colaptes chrysoides*	Woodland Birds <300g	**1**
Pileated Woodpecker	*Dryocopus pileatus*	Woodland Birds <300g	**1**
Ivory-billed Woodpecker	*Campephilus principalis*	Woodland Birds <300g	**1**
Barred Antshrike	*Thamnophilus doliatus*	Woodland Birds <300g	**1**
Northern Beardless-Tyrannulet	*Camptostoma imberbe*	Woodland Birds <300g	**1**
Greenish Elaenia	*Myiopagis viridicata*	Woodland Birds <300g	**1**
Caribbean Elaenia	*Elaenia martinica*	Woodland Birds <300g	**1**
White-crested Elaenia	*Elaenia albiceps*	Woodland Birds <300g	**1**
Tufted Flycatcher	*Mitrephanes phaeocercus*	Woodland Birds <300g	**1**
Olive-sided Flycatcher	*Contopus cooperi*	Woodland Birds <300g	**1**
Greater Pewee	*Contopus pertinax*	Woodland Birds <300g	**1**
Western Wood-Pewee	*Contopus sordidulus*	Woodland Birds <300g	**1**
Eastern Wood-Pewee	*Contopus virens*	Woodland Birds <300g	**1**
Cuban Pewee	*Contopus caribaeus*	Woodland Birds <300g	**1**
Yellow-bellied Flycatcher	*Empidonax flaviventris*	Woodland Birds <300g	**1**
Acadian Flycatcher	*Empidonax virescens*	Woodland Birds <300g	**1**
Alder Flycatcher	*Empidonax alnorum*	Woodland Birds <300g	**1**
Willow Flycatcher	*Empidonax traillii*	Woodland Birds <300g	**1**
Least Flycatcher	*Empidonax minimus*	Woodland Birds <300g	**1**
Hammond's Flycatcher	*Empidonax hammondii*	Woodland Birds <300g	**1**
Gray Flycatcher	*Empidonax wrightii*	Woodland Birds <300g	**1**
Dusky Flycatcher	*Empidonax oberholseri*	Woodland Birds <300g	**1**
Pacific-slope Flycatcher	*Empidonax difficilis*	Woodland Birds <300g	**1**
Cordilleran Flycatcher	*Empidonax occidentalis*	Woodland Birds <300g	**1**
Buff-breasted Flycatcher	*Empidonax fulvifrons*	Woodland Birds <300g	**1**
Black Phoebe	*Sayornis nigricans*	Woodland Birds <300g	**1**
Eastern Phoebe	*Sayornis phoebe*	Woodland Birds <300g	**1**
Say's Phoebe	*Sayornis saya*	Woodland Birds <300g	**1**
Vermilion Flycatcher	*Pyrocephalus rubinus*	Woodland Birds <300g	**1**
Dusky-capped Flycatcher	*Myiarchus tuberculifer*	Woodland Birds <300g	**1**
Ash-throated Flycatcher	*Myiarchus cinerascens*	Woodland Birds <300g	**1**
Nutting's Flycatcher	*Myiarchus nuttingi*	Woodland Birds <300g	**1**
Great Crested Flycatcher	*Myiarchus crinitus*	Woodland Birds <300g	**1**
Brown-crested Flycatcher	*Myiarchus tyrannulus*	Woodland Birds <300g	**1**
La Sagra's Flycatcher	*Myiarchus sagrae*	Woodland Birds <300g	**1**
Great Kiskadee	*Pitangus sulphuratus*	Woodland Birds <300g	**1**

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Woodland Birds (Continued)			
Common Name	**Scientific Name**	**Guild (Mass)**	**Severity**
Social Flycatcher	*Myiozetetes similis*	Woodland Birds <300g	**1**
Sulphur-bellied Flycatcher	*Myiodynastes luteiventris*	Woodland Birds <300g	**1**
Piratic Flycatcher	*Legatus leucophaius*	Woodland Birds <300g	**1**
Variegated Flycatcher	*Empidonomus varius*	Woodland Birds <300g	**1**
Crowned Slaty Flycatcher	*Empidonomus aurantioatrocristatus*	Woodland Birds <300g	**1**
Tropical Kingbird	*Tyrannus melancholicus*	Woodland Birds <300g	**1**
Couch's Kingbird	*Tyrannus couchii*	Woodland Birds <300g	**1**
Cassin's Kingbird	*Tyrannus vociferans*	Woodland Birds <300g	**1**
Thick-billed Kingbird	*Tyrannus crassirostris*	Woodland Birds <300g	**1**
Western Kingbird	*Tyrannus verticalis*	Woodland Birds <300g	**1**
Eastern Kingbird	*Tyrannus tyrannus*	Woodland Birds <300g	**1**
Gray Kingbird	*Tyrannus dominicensis*	Woodland Birds <300g	**1**
Loggerhead Kingbird	*Tyrannus caudifasciatus*	Woodland Birds <300g	**1**
Scissor-tailed Flycatcher	*Tyrannus forficatus*	Woodland Birds <300g	**1**
Fork-tailed Flycatcher	*Tyrannus savana*	Woodland Birds <300g	**1**
Masked Tityra	*Tityra semifasciata*	Woodland Birds <300g	**1**
Gray-collared Becard	*Pachyramphus major*	Woodland Birds <300g	**1**
Rose-throated Becard	*Pachyramphus aglaiae*	Woodland Birds <300g	**1**
Brown Shrike	*Lanius cristatus*	Woodland Birds <300g	**1**
Loggerhead Shrike	*Lanius ludovicianus*	Woodland Birds <300g	**1**
Northern Shrike	*Lanius excubitor*	Woodland Birds <300g	**1**
White-eyed Vireo	*Vireo griseus*	Woodland Birds <300g	**1**
Thick-billed Vireo	*Vireo crassirostris*	Woodland Birds <300g	**1**
Bell's Vireo	*Vireo bellii*	Woodland Birds <300g	**1**
Black-capped Vireo	*Vireo atricapilla*	Woodland Birds <300g	**1**
Gray Vireo	*Vireo vicinior*	Woodland Birds <300g	**1**
Yellow-throated Vireo	*Vireo flavifrons*	Woodland Birds <300g	**1**
Plumbeous Vireo	*Vireo plumbeus*	Woodland Birds <300g	**1**
Cassin's Vireo	*Vireo cassinii*	Woodland Birds <300g	**1**
Blue-headed Vireo	*Vireo solitarius*	Woodland Birds <300g	**1**
Hutton's Vireo	*Vireo huttoni*	Woodland Birds <300g	**1**
Warbling Vireo	*Vireo gilvus*	Woodland Birds <300g	**1**
Philadelphia Vireo	*Vireo philadelphicus*	Woodland Birds <300g	**1**
Red-eyed Vireo	*Vireo olivaceus*	Woodland Birds <300g	**1**
Yellow-green Vireo	*Vireo flavoviridis*	Woodland Birds <300g	**1**
Black-whiskered Vireo	*Vireo altiloquus*	Woodland Birds <300g	**1**
Yucatan Vireo	*Vireo magister*	Woodland Birds <300g	**1**

(*continued on next page*)

Woodland Birds (Continued)			
Common Name	**Scientific Name**	**Guild (Mass)**	**Severity**
Hawaii Elepaio	*Chasiempis sandwichensis*	Woodland Birds <300g	**1**
Kauai Elepaio	*Chasiempis sclateri*	Woodland Birds <300g	**1**
Oahu Elepaio	*Chasiempis ibidis*	Woodland Birds <300g	**1**
Carolina Chickadee	*Poecile carolinensis*	Woodland Birds <300g	**1**
Black-capped Chickadee	*Poecile atricapillus*	Woodland Birds <300g	**1**
Mountain Chickadee	*Poecile gambeli*	Woodland Birds <300g	**1**
Mexican Chickadee	*Poecile sclateri*	Woodland Birds <300g	**1**
Chestnut-backed Chickadee	*Poecile rufescens*	Woodland Birds <300g	**1**
Boreal Chickadee	*Poecile hudsonicus*	Woodland Birds <300g	**1**
Gray-headed Chickadee	*Poecile cinctus*	Woodland Birds <300g	**1**
Japanese Tit	*Parus minor*	Woodland Birds <300g	**1**
Bridled Titmouse	*Baeolophus wollweberi*	Woodland Birds <300g	**1**
Oak Titmouse	*Baeolophus inornatus*	Woodland Birds <300g	**1**
Juniper Titmouse	*Baeolophus ridgwayi*	Woodland Birds <300g	**1**
Tufted Titmouse	*Baeolophus bicolor*	Woodland Birds <300g	**1**
Black-crested Titmouse	*Baeolophus atricristatus*	Woodland Birds <300g	**1**
Verdin	*Auriparus flaviceps*	Woodland Birds <300g	**1**
Bushtit	*Psaltriparus minimus*	Woodland Birds <300g	**1**
Red-breasted Nuthatch	*Sitta canadensis*	Woodland Birds <300g	**1**
White-breasted Nuthatch	*Sitta carolinensis*	Woodland Birds <300g	**1**
Pygmy Nuthatch	*Sitta pygmaea*	Woodland Birds <300g	**1**
Brown-headed Nuthatch	*Sitta pusilla*	Woodland Birds <300g	**1**
Brown Creeper	*Certhia americana*	Woodland Birds <300g	**1**
Rock Wren	*Salpinctes obsoletus*	Woodland Birds <300g	**1**
Canyon Wren	*Catherpes mexicanus*	Woodland Birds <300g	**1**
Eurasian Wren	*Troglodytes troglodytes*	Woodland Birds <300g	**1**
House Wren	*Troglodytes aedon*	Woodland Birds <300g	**1**
Pacific Wren	*Troglodytes pacificus*	Woodland Birds <300g	**1**
Winter Wren	*Troglodytes hiemalis*	Woodland Birds <300g	**1**
Sedge Wren	*Cistothorus platensis*	Woodland Birds <300g	**1**
Marsh Wren	*Cistothorus palustris*	Woodland Birds <300g	**1**
Carolina Wren	*Thryothorus ludovicianus*	Woodland Birds <300g	**1**
Bewick's Wren	*Thryomanes bewickii*	Woodland Birds <300g	**1**
Cactus Wren	*Campylorhynchus brunneicapillus*	Woodland Birds <300g	**1**
Sinaloa Wren	*Thryophilus sinaloa*	Woodland Birds <300g	**1**
Blue-gray Gnatcatcher	*Polioptila caerulea*	Woodland Birds <300g	**1**
California Gnatcatcher	*Polioptila californica*	Woodland Birds <300g	**1**

(*continued on next page*)

Woodland Birds (Continued)			
Common Name	**Scientific Name**	**Guild (Mass)**	**Severity**
Black-tailed Gnatcatcher	*Polioptila melanura*	Woodland Birds <300g	1
Black-capped Gnatcatcher	*Polioptila nigriceps*	Woodland Birds <300g	1
Red-vented Bulbul	*Pycnonotus cafer*	Woodland Birds <300g	1
Red-whiskered Bulbul	*Pycnonotus jocosus*	Woodland Birds <300g	1
Golden-crowned Kinglet	*Regulus satrapa*	Woodland Birds <300g	1
Ruby-crowned Kinglet	*Regulus calendula*	Woodland Birds <300g	1
Japanese Bush-Warbler	*Cettia diphone*	Woodland Birds <300g	1
Willow Warbler	*Phylloscopus trochilus*	Woodland Birds <300g	1
Common Chiffchaff	*Phylloscopus collybita*	Woodland Birds <300g	1
Wood Warbler	*Phylloscopus sibilatrix*	Woodland Birds <300g	1
Dusky Warbler	*Phylloscopus fuscatus*	Woodland Birds <300g	1
Pallas's Leaf Warbler	*Phylloscopus proregulus*	Woodland Birds <300g	1
Yellow-browed Warbler	*Phylloscopus inornatus*	Woodland Birds <300g	1
Arctic Warbler	*Phylloscopus borealis*	Woodland Birds <300g	1
Kamchatka Leaf Warbler	*Phylloscopus examinandus*	Woodland Birds <300g	1
Lesser Whitethroat	*Sylvia curruca*	Woodland Birds <300g	1
Wrentit	*Chamaea fasciata*	Woodland Birds <300g	1
Japanese White-eye	*Zosterops japonicus*	Woodland Birds <300g	1
Chinese Hwamei	*Garrulax canorus*	Woodland Birds <300g	1
Gray-sided Laughingthrush	*Lanthocincla caerulata*	Woodland Birds <300g	1
Red-billed Leiothrix	*Leiothrix lutea*	Woodland Birds <300g	1
Millerbird	*Acrocephalus familiaris*	Woodland Birds <300g	1
Sedge Warbler	*Acrocephalus schoenobaenus*	Woodland Birds <300g	1
Middendorff's Grasshopper-Warbler	*Locustella ochotensis*	Woodland Birds <300g	1
Lanceolated Warbler	*Locustella lanceolata*	Woodland Birds <300g	1
Gray-streaked Flycatcher	*Muscicapa griseisticta*	Woodland Birds <300g	1
Asian Brown Flycatcher	*Muscicapa latirostris*	Woodland Birds <300g	1
Spotted Flycatcher	*Muscicapa striata*	Woodland Birds <300g	1
Dark-sided Flycatcher	*Muscicapa sibirica*	Woodland Birds <300g	1
White-rumped Shama	*Copsychus malabaricus*	Woodland Birds <300g	1
Rufous-tailed Robin	*Larvivora sibilans*	Woodland Birds <300g	1
Siberian Blue Robin	*Lavivora cyane*	Woodland Birds <300g	1
Bluethroat	*Luscinia svecica*	Woodland Birds <300g	1
Siberian Rubythroat	*Calliope calliope*	Woodland Birds <300g	1
Red-flanked Bluetail	*Tarsiger cyanurus*	Woodland Birds <300g	1
Narcissus Flycatcher	*Ficedula narcissina*	Woodland Birds <300g	1

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Woodland Birds (Continued)			
Common Name	**Scientific Name**	**Guild (Mass)**	**Severity**
Mugimaki Flycatcher	*Ficedula mugimaki*	Woodland Birds <300g	**1**
Common Redstart	*Phoenicurus phoenicurus*	Woodland Birds <300g	**1**
Blue Rock-Thrush	*Monticola solitarius*	Woodland Birds <300g	**1**
Siberian Stonechat	*Saxicola maurus*	Woodland Birds <300g	**1**
Taiga Flycatcher	*Ficedula albicilla*	Woodland Birds <300g	**1**
Northern Wheatear	*Oenanthe oenanthe*	Woodland Birds <300g	**1**
Eastern Bluebird	*Sialia sialis*	Woodland Birds <300g	**1**
Western Bluebird	*Sialia mexicana*	Woodland Birds <300g	**1**
Mountain Bluebird	*Sialia currucoides*	Woodland Birds <300g	**1**
Townsend's Solitaire	*Myadestes townsendi*	Woodland Birds <300g	**1**
Olomao	*Myadestes lanaiensis*	Woodland Birds <300g	**1**
Omao	*Myadestes obscurus*	Woodland Birds <300g	**1**
Puaiohi	*Myadestes palmeri*	Woodland Birds <300g	**1**
Orange-billed Nightingale-Thrush	*Catharus aurantiirostris*	Woodland Birds <300g	**1**
Black-headed Nightingale-Thrush	*Catharus mexicanus*	Woodland Birds <300g	**1**
Veery	*Catharus fuscescens*	Woodland Birds <300g	**1**
Gray-cheeked Thrush	*Catharus minimus*	Woodland Birds <300g	**1**
Bicknell's Thrush	*Catharus bicknelli*	Woodland Birds <300g	**1**
Swainson's Thrush	*Catharus ustulatus*	Woodland Birds <300g	**1**
Hermit Thrush	*Catharus guttatus*	Woodland Birds <300g	**1**
Wood Thrush	*Hylocichla mustelina*	Woodland Birds <300g	**1**
Eurasian Blackbird	*Turdus merula*	Woodland Birds <300g	**1**
Eyebrowed Thrush	*Turdus obscurus*	Woodland Birds <300g	**1**
Dusky Thrush	*Turdus naumanni*	Woodland Birds <300g	**1**
Fieldfare	*Turdus pilaris*	Woodland Birds <300g	**1**
Redwing	*Turdus iliacus*	Woodland Birds <300g	**1**
Song Thrush	*Turdus philomelos*	Woodland Birds <300g	**1**
Clay-colored Thrush	*Turdus grayi*	Woodland Birds <300g	**1**
White-throated Thrush	*Turdus assimilis*	Woodland Birds <300g	**1**
Rufous-backed Robin	*Turdus rufopalliatus*	Woodland Birds <300g	**1**
American Robin	*Turdus migratorius*	Woodland Birds <300g	**1**
Varied Thrush	*Ixoreus naevius*	Woodland Birds <300g	**1**
Aztec Thrush	*Ridgwayia pinicola*	Woodland Birds <300g	**1**
Blue Mockingbird	*Melanotis caerulescens*	Woodland Birds <300g	**1**
Black Catbird	*Melanoptila glabrirostris*	Woodland Birds <300g	**1**
Gray Catbird	*Dumetella carolinensis*	Woodland Birds <300g	**1**
Curve-billed Thrasher	*Toxostoma curvirostre*	Woodland Birds <300g	**1**

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Woodland Birds (Continued)			
Common Name	**Scientific Name**	**Guild (Mass)**	**Severity**
Brown Thrasher	*Toxostoma rufum*	Woodland Birds <300g	1
Long-billed Thrasher	*Toxostoma longirostre*	Woodland Birds <300g	1
Bendire's Thrasher	*Toxostoma bendirei*	Woodland Birds <300g	1
California Thrasher	*Toxostoma redivivum*	Woodland Birds <300g	1
Le Conte's Thrasher	*Toxostoma lecontei*	Woodland Birds <300g	1
Crissal Thrasher	*Toxostoma crissale*	Woodland Birds <300g	1
Sage Thrasher	*Oreoscoptes montanus*	Woodland Birds <300g	1
Bahama Mockingbird	*Mimus gundlachii*	Woodland Birds <300g	1
Tropical Mockingbird	*Mimus gilvus*	Woodland Birds <300g	1
Northern Mockingbird	*Mimus polyglottos*	Woodland Birds <300g	1
European Starling	*Sturnus vulgaris*	Woodland Birds <300g	1
Common Myna	*Acridotheres tristis*	Woodland Birds <300g	1
Common Hill Myna	*Gracula religiosa*	Woodland Birds <300g	1
Crested Myna	*Acridotheres cristatellus*	Woodland Birds <300g	1
Jungle Myna	*Acridotheres fuscus*	Woodland Birds <300g	1
Siberian Accentor	*Prunella montanella*	Woodland Birds <300g	1
Western Yellow Wagtail	*Motacilla flava*	Woodland Birds <300g	1
Eastern Yellow Wagtail	*Motacilla tschutschensis*	Woodland Birds <300g	1
Citrine Wagtail	*Motacilla citreola*	Woodland Birds <300g	1
Gray Wagtail	*Motacilla cinerea*	Woodland Birds <300g	1
White Wagtail	*Motacilla alba*	Woodland Birds <300g	1
Tree Pipit	*Anthus trivialis*	Woodland Birds <300g	1
Bohemian Waxwing	*Bombycilla garrulus*	Woodland Birds <300g	1
Cedar Waxwing	*Bombycilla cedrorum*	Woodland Birds <300g	1
Gray Silky-flycatcher	*Ptiliogonys cinereus*	Woodland Birds <300g	1
Phainopepla	*Phainopepla nitens*	Woodland Birds <300g	1
Olive Warbler	*Peucedramus taeniatus*	Woodland Birds <300g	1
Ovenbird	*Seiurus aurocapilla*	Woodland Birds <300g	1
Worm-eating Warbler	*Helmitheros vermivorum*	Woodland Birds <300g	1
Louisiana Waterthrush	*Parkesia motacilla*	Woodland Birds <300g	1
Northern Waterthrush	*Parkesia noveboracensis*	Woodland Birds <300g	1
Bachman's Warbler	*Vermivora bachmanii*	Woodland Birds <300g	1
Golden-winged Warbler	*Vermivora chrysoptera*	Woodland Birds <300g	1
Blue-winged Warbler	*Vermivora cyanoptera*	Woodland Birds <300g	1
Black-and-white Warbler	*Mniotilta varia*	Woodland Birds <300g	1
Prothonotary Warbler	*Protonotaria citrea*	Woodland Birds <300g	1
Swainson's Warbler	*Limnothlypis swainsonii*	Woodland Birds <300g	1
Crescent-chested Warbler	*Oreothlypis superciliosa*	Woodland Birds <300g	1

(*continued on next page*)

Woodland Birds (Continued)			
Common Name	**Scientific Name**	**Guild (Mass)**	**Severity**
Tennessee Warbler	*Oreothlypis peregrina*	Woodland Birds <300g	**1**
Orange-crowned Warbler	*Oreothlypis celata*	Woodland Birds <300g	**1**
Colima Warbler	*Oreothlypis crissalis*	Woodland Birds <300g	**1**
Lucy's Warbler	*Oreothlypis luciae*	Woodland Birds <300g	**1**
Nashville Warbler	*Oreothlypis ruficapilla*	Woodland Birds <300g	**1**
Virginia's Warbler	*Oreothlypis virginiae*	Woodland Birds <300g	**1**
Connecticut Warbler	*Oporornis agilis*	Woodland Birds <300g	**1**
Gray-crowned Yellowthroat	*Geothlypis poliocephala*	Woodland Birds <300g	**1**
MacGillivray's Warbler	*Geothlypis tolmiei*	Woodland Birds <300g	**1**
Mourning Warbler	*Geothlypis philadelphia*	Woodland Birds <300g	**1**
Kentucky Warbler	*Geothlypis formosa*	Woodland Birds <300g	**1**
Common Yellowthroat	*Geothlypis trichas*	Woodland Birds <300g	**1**
Hooded Yellowthroat	*Geothlypis nelsoni*	Woodland Birds <300g	**1**
Hooded Warbler	*Setophaga citrina*	Woodland Birds <300g	**1**
American Redstart	*Setophaga ruticilla*	Woodland Birds <300g	**1**
Kirtland's Warbler	*Setophaga kirtlandii*	Woodland Birds <300g	**1**
Cape May Warbler	*Setophaga tigrina*	Woodland Birds <300g	**1**
Cerulean Warbler	*Setophaga cerulea*	Woodland Birds <300g	**1**
Northern Parula	*Setophaga americana*	Woodland Birds <300g	**1**
Tropical Parula	*Setophaga pitiayumi*	Woodland Birds <300g	**1**
Magnolia Warbler	*Setophaga magnolia*	Woodland Birds <300g	**1**
Bay-breasted Warbler	*Setophaga castanea*	Woodland Birds <300g	**1**
Blackburnian Warbler	*Setophaga fusca*	Woodland Birds <300g	**1**
Yellow Warbler	*Setophaga petechia*	Woodland Birds <300g	**1**
Chestnut-sided Warbler	*Setophaga pensylvanica*	Woodland Birds <300g	**1**
Blackpoll Warbler	*Setophaga striata*	Woodland Birds <300g	**1**
Black-throated Blue Warbler	*Setophaga caerulescens*	Woodland Birds <300g	**1**
Palm Warbler	*Setophaga palmarum*	Woodland Birds <300g	**1**
Pine Warbler	*Setophaga pinus*	Woodland Birds <300g	**1**
Yellow-rumped Warbler	*Setophaga coronata*	Woodland Birds <300g	**1**
Yellow-throated Warbler	*Setophaga dominica*	Woodland Birds <300g	**1**
Prairie Warbler	*Setophaga discolor*	Woodland Birds <300g	**1**
Grace's Warbler	*Setophaga graciae*	Woodland Birds <300g	**1**
Black-throated Gray Warbler	*Setophaga nigrescens*	Woodland Birds <300g	**1**
Townsend's Warbler	*Setophaga townsendi*	Woodland Birds <300g	**1**
Hermit Warbler	*Setophaga occidentalis*	Woodland Birds <300g	**1**

(*continued on next page*)

Woodland Birds (Continued)			
Common Name	**Scientific Name**	**Guild (Mass)**	**Severity**
Golden-cheeked Warbler	*Setophaga chrysoparia*	Woodland Birds <300g	**1**
Black-throated Green Warbler	*Setophaga virens*	Woodland Birds <300g	**1**
Fan-tailed Warbler	*Basileuterus lachrymosus*	Woodland Birds <300g	**1**
Rufous-capped Warbler	*Basileuterus rufifrons*	Woodland Birds <300g	**1**
Golden-crowned Warbler	*Basileuterus culicivorus*	Woodland Birds <300g	**1**
Canada Warbler	*Cardellina canadensis*	Woodland Birds <300g	**1**
Wilson's Warbler	*Cardellina pusilla*	Woodland Birds <300g	**1**
Red-faced Warbler	*Cardellina rubrifrons*	Woodland Birds <300g	**1**
Painted Redstart	*Myioborus pictus*	Woodland Birds <300g	**1**
Slate-throated Redstart	*Myioborus miniatus*	Woodland Birds <300g	**1**
Yellow-breasted Chat	*Icteria virens*	Woodland Birds <300g	**1**
Bananaquit	*Coereba flaveola*	Woodland Birds <300g	**1**
Red-crested Cardinal	*Paroaria coronata*	Woodland Birds <300g	**1**
Yellow-billed Cardinal	*Paroaria capitata*	Woodland Birds <300g	**1**
Crimson-collared Tanager	*Ramphocelus sanguinolentus*	Woodland Birds <300g	**1**
Saffron Finch	*Sicalis flaveola*	Woodland Birds <300g	**1**
White-collared Seedeater	*Sporophila torqueola*	Woodland Birds <300g	**1**
Yellow-faced Grassquit	*Tiaris olivaceus*	Woodland Birds <300g	**1**
Black-faced Grassquit	*Tiaris bicolor*	Woodland Birds <300g	**1**
Greater Antillean Bullfinch	*Loxigilla violacea*	Woodland Birds <300g	**1**
Western Spindalis	*Spindalis zena*	Woodland Birds <300g	**1**
Olive Sparrow	*Arremonops rufivirgatus*	Woodland Birds <300g	**1**
Green-tailed Towhee	*Pipilo chlorurus*	Woodland Birds <300g	**1**
Spotted Towhee	*Pipilo maculatus*	Woodland Birds <300g	**1**
Eastern Towhee	*Pipilo erythrophthalmus*	Woodland Birds <300g	**1**
Rufous-crowned Sparrow	*Aimophila ruficeps*	Woodland Birds <300g	**1**
Canyon Towhee	*Melozone fusca*	Woodland Birds <300g	**1**
California Towhee	*Melozone crissalis*	Woodland Birds <300g	**1**
Abert's Towhee	*Melozone aberti*	Woodland Birds <300g	**1**
Rufous-winged Sparrow	*Peucaea carpalis*	Woodland Birds <300g	**1**
Striped Sparrow	*Oriturus superciliosus*	Woodland Birds <300g	**1**
American Tree Sparrow	*Spizella arborea*	Woodland Birds <300g	**1**
Chipping Sparrow	*Spizella passerina*	Woodland Birds <300g	**1**
Black-chinned Sparrow	*Spizella atrogularis*	Woodland Birds <300g	**1**
Five-striped Sparrow	*Amphispiza quinquestriata*	Woodland Birds <300g	**1**
Black-throated Sparrow	*Amphispiza bilineata*	Woodland Birds <300g	**1**

(*continued on next page*)

Woodland Birds (Continued)			
Common Name	**Scientific Name**	**Guild (Mass)**	**Severity**
Sagebrush Sparrow	*Artemisiospiza nevadensis*	Woodland Birds <300g	**1**
Bell's Sparrow	*Artemisiospiza belli*	Woodland Birds <300g	**1**
Nelson's Sparrow	*Ammodramus nelsoni*	Woodland Birds <300g	**1**
Saltmarsh Sparrow	*Ammodramus caudacutus*	Woodland Birds <300g	**1**
Seaside Sparrow	*Ammodramus maritimus*	Woodland Birds <300g	**1**
Fox Sparrow	*Passerella iliaca*	Woodland Birds <300g	**1**
Song Sparrow	*Melospiza melodia*	Woodland Birds <300g	**1**
Lincoln's Sparrow	*Melospiza lincolnii*	Woodland Birds <300g	**1**
Swamp Sparrow	*Melospiza georgiana*	Woodland Birds <300g	**1**
White-throated Sparrow	*Zonotrichia albicollis*	Woodland Birds <300g	**1**
Harris's Sparrow	*Zonotrichia querula*	Woodland Birds <300g	**1**
White-crowned Sparrow	*Zonotrichia leucophrys*	Woodland Birds <300g	**1**
Golden-crowned Sparrow	*Zonotrichia atricapilla*	Woodland Birds <300g	**1**
Dark-eyed Junco	*Junco hyemalis*	Woodland Birds <300g	**1**
Yellow-eyed Junco	*Junco phaeonotus*	Woodland Birds <300g	**1**
Pine Bunting	*Emberiza leucocephalos*	Woodland Birds <300g	**1**
Yellow-browed Bunting	*Emberiza chrysophrys*	Woodland Birds <300g	**1**
Little Bunting	*Emberiza pusilla*	Woodland Birds <300g	**1**
Rustic Bunting	*Emberiza rustica*	Woodland Birds <300g	**1**
Yellow-throated Bunting	*Emberiza elegans*	Woodland Birds <300g	**1**
Yellow-breasted Bunting	*Emberiza aureola*	Woodland Birds <300g	**1**
Gray Bunting	*Emberiza variabilis*	Woodland Birds <300g	**1**
Pallas's Bunting	*Emberiza pallasi*	Woodland Birds <300g	**1**
Reed Bunting	*Emberiza schoeniclus*	Woodland Birds <300g	**1**
Hepatic Tanager	*Piranga flava*	Woodland Birds <300g	**1**
Summer Tanager	*Piranga rubra*	Woodland Birds <300g	**1**
Scarlet Tanager	*Piranga olivacea*	Woodland Birds <300g	**1**
Western Tanager	*Piranga ludoviciana*	Woodland Birds <300g	**1**
Flame-colored Tanager	*Piranga bidentata*	Woodland Birds <300g	**1**
Crimson-collared Grosbeak	*Rhodothraupis celaeno*	Woodland Birds <300g	**1**
Northern Cardinal	*Cardinalis cardinalis*	Woodland Birds <300g	**1**
Pyrrhuloxia	*Cardinalis sinuatus*	Woodland Birds <300g	**1**
Yellow Grosbeak	*Pheucticus chrysopeplus*	Woodland Birds <300g	**1**
Rose-breasted Grosbeak	*Pheucticus ludovicianus*	Woodland Birds <300g	**1**
Black-headed Grosbeak	*Pheucticus melanocephalus*	Woodland Birds <300g	**1**
Blue Bunting	*Cyanocompsa parellina*	Woodland Birds <300g	**1**

(*continued on next page*)

Woodland Birds (Continued)			
Common Name	**Scientific Name**	**Guild (Mass)**	**Severity**
Blue Grosbeak	*Passerina caerulea*	Woodland Birds <300g	1
Lazuli Bunting	*Passerina amoena*	Woodland Birds <300g	1
Indigo Bunting	*Passerina cyanea*	Woodland Birds <300g	1
Varied Bunting	*Passerina versicolor*	Woodland Birds <300g	1
Painted Bunting	*Passerina ciris*	Woodland Birds <300g	1
Dickcissel	*Spiza americana*	Woodland Birds <300g	1
Black-vented Oriole	*Icterus wagleri*	Woodland Birds <300g	1
Orchard Oriole	*Icterus spurius*	Woodland Birds <300g	1
Hooded Oriole	*Icterus cucullatus*	Woodland Birds <300g	1
Venezuelan Troupial	*Icterus icterus*	Woodland Birds <300g	1
Streak-backed Oriole	*Icterus pustulatus*	Woodland Birds <300g	1
Bullock's Oriole	*Icterus bullockii*	Woodland Birds <300g	1
Spot-breasted Oriole	*Icterus pectoralis*	Woodland Birds <300g	1
Altamira Oriole	*Icterus gularis*	Woodland Birds <300g	1
Audubon's Oriole	*Icterus graduacauda*	Woodland Birds <300g	1
Baltimore Oriole	*Icterus galbula*	Woodland Birds <300g	1
Scott's Oriole	*Icterus parisorum*	Woodland Birds <300g	1
Montezuma Oropendola	*Psarocolius montezuma*	Woodland Birds <300g	1
Common Chaffinch	*Fringilla coelebs*	Woodland Birds <300g	1
Brambling	*Fringilla montifringilla*	Woodland Birds <300g	1
Asian Rosy-Finch	*Leucosticte arctoa*	Woodland Birds <300g	1
Gray-crowned Rosy-Finch	*Leucosticte tephrocotis*	Woodland Birds <300g	1
Black Rosy-Finch	*Leucosticte atrata*	Woodland Birds <300g	1
Brown-capped Rosy-Finch	*Leucosticte australis*	Woodland Birds <300g	1
Trumpeter Finch	*Bucanetes githagineus*	Woodland Birds <300g	1
Pine Grosbeak	*Pinicola enucleator*	Woodland Birds <300g	1
Eurasian Bullfinch	*Pyrrhula pyrrhula*	Woodland Birds <300g	1
Laysan Finch	*Telespiza cantans*	Woodland Birds <300g	1
Nihoa Finch	*Telespiza ultima*	Woodland Birds <300g	1
Ou	*Psittirostra psittacea*	Woodland Birds <300g	1
Palila	*Loxioides bailleui*	Woodland Birds <300g	1
Maui Parrotbill	*Pseudonestor xanthophrys*	Woodland Birds <300g	1
Hawaii Amakihi	*Hemignathus virens*	Woodland Birds <300g	1
Oahu Amakihi	*Hemignathus flavus*	Woodland Birds <300g	1
Kauai Amakihi	*Hemignathus kauaiensis*	Woodland Birds <300g	1
Nukupuu	*Hemignathus lucidus*	Woodland Birds <300g	1
Akiapolaau	*Hemignathus munroi*	Woodland Birds <300g	1
Anianiau	*Magumma parva*	Woodland Birds <300g	1

(*continued on next page*)

Woodland Birds (Continued)			
Common Name	**Scientific Name**	**Guild (Mass)**	**Severity**
Akikiki	*Oreomystis bairdi*	Woodland Birds <300g	**1**
Oahu Alauahio	*Paroreomyza maculata*	Woodland Birds <300g	**1**
Maui Alauahio	*Paroreomyza montana*	Woodland Birds <300g	**1**
Hawaii Creeper	*Loxops mana*	Woodland Birds <300g	**1**
Akekee	*Loxops caeruleirostris*	Woodland Birds <300g	**1**
Akepa	*Loxops coccineus*	Woodland Birds <300g	**1**
Iiwi	*Vestiaria coccinea*	Woodland Birds <300g	**1**
Akohekohe	*Palmeria dolei*	Woodland Birds <300g	**1**
Apapane	*Himatione sanguinea*	Woodland Birds <300g	**1**
Poo-uli	*Melamprosops phaeosoma*	Woodland Birds <300g	**1**
Common Rosefinch	*Carpodacus erythrinus*	Woodland Birds <300g	**1**
House Finch	*Haemorhous mexicanus*	Woodland Birds <300g	**1**
Purple Finch	*Haemorhous purpureus*	Woodland Birds <300g	**1**
Cassin's Finch	*Haemorhous cassinii*	Woodland Birds <300g	**1**
Red Crossbill	*Loxia curvirostra*	Woodland Birds <300g	**1**
White-winged Crossbill	*Loxia leucoptera*	Woodland Birds <300g	**1**
Common Redpoll	*Acanthis flammea*	Woodland Birds <300g	**1**
Hoary Redpoll	*Acanthis hornemanni*	Woodland Birds <300g	**1**
Eurasian Siskin	*Spinus spinus*	Woodland Birds <300g	**1**
Pine Siskin	*Spinus pinus*	Woodland Birds <300g	**1**
Black-headed Siskin	*Spinus notatus*	Woodland Birds <300g	**1**
Lesser Goldfinch	*Spinus psaltria*	Woodland Birds <300g	**1**
Lawrence's Goldfinch	*Spinus lawrencei*	Woodland Birds <300g	**1**
American Goldfinch	*Spinus tristis*	Woodland Birds <300g	**1**
European Goldfinch	*Carduelis carduelis*	Woodland Birds <300g	**1**
Oriental Greenfinch	*Chloris sinica*	Woodland Birds <300g	**1**
Island Canary	*Serinus canaria*	Woodland Birds <300g	**1**
Yellow-fronted Canary	*Serinus mozambicus*	Woodland Birds <300g	**1**
European Serin	*Serinus serinus*	Woodland Birds <300g	**1**
Evening Grosbeak	*Coccothraustes vespertinus*	Woodland Birds <300g	**1**
Hawfinch	*Coccothraustes coccothraustes*	Woodland Birds <300g	**1**
House Sparrow	*Passer domesticus*	Woodland Birds <300g	**1**
Eurasian Tree Sparrow	*Passer montanus*	Woodland Birds <300g	**1**
Northern Red Bishop	*Euplectes franciscanus*	Woodland Birds <300g	**1**
Yellow-crowned Bishop	*Euplectes afer*	Woodland Birds <300g	**1**
Red-cheeked Cordonbleu	*Uraeginthus bengalus*	Woodland Birds <300g	**1**
Lavender Waxbill	*Estrilda caerulescens*	Woodland Birds <300g	**1**

(*continued on next page*)

Woodland Birds (Continued)			
Common Name	**Scientific Name**	**Guild (Mass)**	**Severity**
Orange-cheeked Waxbill	*Estrilda melpoda*	Woodland Birds <300g	**1**
Black-rumped Waxbill	*Estrilda troglodytes*	Woodland Birds <300g	**1**
Common Waxbill	*Estrilda astrild*	Woodland Birds <300g	**1**
Red Avadavat	*Amandava amandava*	Woodland Birds <300g	**1**
Zebra finch	*Taeniopygia guttata*	Woodland Birds <300g	**1**
Indian Silverbill	*Euodice malabarica*	Woodland Birds <300g	**1**
African Silverbill	*Euodice cantans*	Woodland Birds <300g	**1**
Madagascar Munia	*Lonchura nana*	Woodland Birds <300g	**1**
Java Sparrow	*Lonchura oryzivora*	Woodland Birds <300g	**1**
Scaly-breasted Munia	*Lonchura punctulata*	Woodland Birds <300g	**1**
Tricolored Munia	*Lonchura malacca*	Woodland Birds <300g	**1**
Chestnut Munia	*Lonchura atricapilla*	Woodland Birds <300g	**1**
White-headed Munia	*Lonchura maja*	Woodland Birds <300g	**1**
Pin-tailed Whydah	*Vidua macroura*	Woodland Birds <300g	**1**
Corvids			
		If Flocks < 15	**4**
		If Flocks ≥ 15	**5**
Common Name	**Scientific Name**	**Guild (Mass)**	**Severity**
Gray Jay	*Perisoreus canadensis*	Corvids <300g	**1**
Black-throated Magpie-Jay	*Calocitta colliei*	Corvids <300g	**1**
Brown Jay	*Psilorhinus morio*	Corvids <300g	**1**
Green Jay	*Cyanocorax yncas*	Corvids <300g	**1**
Azure Jay	*Cyanocorax caeruleus*	Corvids <300g	**1**
Pinyon Jay	*Gymnorhinus cyanocephalus*	Corvids <300g	**1**
Steller's Jay	*Cyanocitta stelleri*	Corvids <300g	**1**
Blue Jay	*Cyanocitta cristata*	Corvids <300g	**1**
Florida Scrub-Jay	*Aphelocoma coerulescens*	Corvids <300g	**1**
Island Scrub-Jay	*Aphelocoma insularis*	Corvids <300g	**1**
Western Scrub-Jay	*Aphelocoma californica*	Corvids <300g	**1**
Mexican Jay	*Aphelocoma wollweberi*	Corvids <300g	**1**
Clark's Nutcracker	*Nucifraga columbiana*	Corvids <300g	**1**
Black-billed Magpie	*Pica hudsonia*	Corvids <300g	**1**
Yellow-billed Magpie	*Pica nuttalli*	Corvids <300g	**1**
Eurasian Jackdaw	*Corvus monedula*	Corvids 300-999g	**2**
American Crow	*Corvus brachyrhynchos*	Corvids 300-999g	**2**
Northwestern Crow	*Corvus caurinus*	Corvids 300-999g	**2**
Tamaulipas Crow	*Corvus imparatus*	Corvids 300-999g	**2**

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Corvids			
		If Flocks < 15	**4**
		If Flocks ≥ 15	**5**
Common Name	**Scientific Name**	**Guild (Mass)**	**Severity**
Fish Crow	*Corvus ossifragus*	Corvids 300-999g	**2**
Hawaiian Crow	*Corvus hawaiiensis*	Corvids 300-999g	**2**
Chihuahuan Raven	*Corvus cryptoleucus*	Corvids 300-999g	**2**
Common Raven	*Corvus corax*	Corvids 1000-1999g	**3**
Grassland Birds			
Common Name	**Scientific Name**	**Guild (Mass)**	**Severity**
Scissor-tailed Flycatcher	*Tyrannus forficatus*	Grassland Birds <300g	**1**
Sky Lark	*Alauda arvensis*	Grassland Birds <300g	**1**
Horned Lark	*Eremophila alpestris*	Grassland Birds <300g	**1**
Olive-backed Pipit	*Anthus hodgsoni*	Grassland Birds <300g	**1**
Pechora Pipit	*Anthus gustavi*	Grassland Birds <300g	**1**
Red-throated Pipit	*Anthus cervinus*	Grassland Birds <300g	**1**
American Pipit	*Anthus rubescens*	Grassland Birds <300g	**1**
Sprague's Pipit	*Anthus spragueii*	Grassland Birds <300g	**1**
Lapland Longspur	*Calcarius lapponicus*	Grassland Birds <300g	**1**
Chestnut-collared Longspur	*Calcarius ornatus*	Grassland Birds <300g	**1**
Smith's Longspur	*Calcarius pictus*	Grassland Birds <300g	**1**
McCown's Longspur	*Rhynchophanes mccownii*	Grassland Birds <300g	**1**
Snow Bunting	*Plectrophenax nivalis*	Grassland Birds <300g	**1**
McKay's Bunting	*Plectrophenax hyperboreus*	Grassland Birds <300g	**1**
Botteri's Sparrow	*Peucaea botterii*	Grassland Birds <300g	**1**
Cassin's Sparrow	*Peucaea cassinii*	Grassland Birds <300g	**1**
Bachman's Sparrow	*Peucaea aestivalis*	Grassland Birds <300g	**1**
Clay-colored Sparrow	*Spizella pallida*	Grassland Birds <300g	**1**
Brewer's Sparrow	*Spizella breweri*	Grassland Birds <300g	**1**
Field Sparrow	*Spizella pusilla*	Grassland Birds <300g	**1**
Worthen's Sparrow	*Spizella wortheni*	Grassland Birds <300g	**1**
Vesper Sparrow	*Pooecetes gramineus*	Grassland Birds <300g	**1**
Lark Sparrow	*Chondestes grammacus*	Grassland Birds <300g	**1**
Lark Bunting	*Calamospiza melanocorys*	Grassland Birds <300g	**1**
Savannah Sparrow	*Passerculus sandwichensis*	Grassland Birds <300g	**1**
Grasshopper Sparrow	*Ammodramus savannarum*	Grassland Birds <300g	**1**
Baird's Sparrow	*Ammodramus bairdii*	Grassland Birds <300g	**1**
Henslow's Sparrow	*Ammodramus henslowii*	Grassland Birds <300g	**1**
Le Conte's Sparrow	*Ammodramus leconteii*	Grassland Birds <300g	**1**

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Blackbirds/Starlings			
Common Name	**Scientific Name**	**Guild (Mass)**	**Severity**
European Starling	*Sturnus vulgaris*	Blackbirds/Starlings <300g	**1**
Common Myna	*Acridotheres tristis*	Blackbirds/Starlings <300g	**1**
Common Hill Myna	*Gracula religiosa*	Blackbirds/Starlings <300g	**1**
Crested Myna	*Acridotheres cristatellus*	Blackbirds/Starlings <300g	**1**
Jungle Myna	*Acridotheres fuscus*	Blackbirds/Starlings <300g	**1**
Bobolink	*Dolichonyx oryzivorus*	Blackbirds/Starlings <300g	**1**
Red-winged Blackbird	*Agelaius phoeniceus*	Blackbirds/Starlings <300g	**1**
Tricolored Blackbird	*Agelaius tricolor*	Blackbirds/Starlings <300g	**1**
Tawny-shouldered Blackbird	*Agelaius humeralis*	Blackbirds/Starlings <300g	**1**
Eastern Meadowlark	*Sturnella magna*	Blackbirds/Starlings <300g	**1**
Western Meadowlark	*Sturnella neglecta*	Blackbirds/Starlings <300g	**1**
Yellow-headed Blackbird	*Xanthocephalus xanthocephalus*	Blackbirds/Starlings <300g	**1**
Rusty Blackbird	*Euphagus carolinus*	Blackbirds/Starlings <300g	**1**
Brewer's Blackbird	*Euphagus cyanocephalus*	Blackbirds/Starlings <300g	**1**
Common Grackle	*Quiscalus quiscula*	Blackbirds/Starlings <300g	**1**
Boat-tailed Grackle	*Quiscalus major*	Blackbirds/Starlings <300g	**1**
Great-tailed Grackle	*Quiscalus mexicanus*	Blackbirds/Starlings <300g	**1**
Shiny Cowbird	*Molothrus bonariensis*	Blackbirds/Starlings <300g	**1**
Bronzed Cowbird	*Molothrus aeneus*	Blackbirds/Starlings <300g	**1**
Brown-headed Cowbird	*Molothrus ater*	Blackbirds/Starlings <300g	**1**
Miscellaneous			
Common Name	**Scientific Name**	**Guild (Mass)**	**Severity**
Ringed Kingfisher	*Megaceryle torquata*	Miscellaneous <300g	**1**
Belted Kingfisher	*Megaceryle alcyon*	Miscellaneous <300g	**1**
Amazon Kingfisher	*Chloroceryle amazona*	Miscellaneous <300g	**1**
Green Kingfisher	*Chloroceryle americana*	Miscellaneous <300g	**1**
American Dipper	*Cinclus mexicanus*	Miscellaneous <300g	**1**
Lesser Roadrunner	*Geococcyx velox*	Miscellaneous 300-999g	**2**
Greater Roadrunner	*Geococcyx californianus*	Miscellaneous 300-999g	**2**

Attachment 9: The Advanced-Version WHaMRAT Mammalian Species List by Guild and Severity Score

Weights expressed in grams (g)

Rodents			
Common Name	**Scientific Name**	**Guild (Mass)**	**Severity**
Woodland jumping mouse	*Napaeozapus insignis*	Rodent <100g	**1**
Meadow jumping mouse	*Zapus hudsonius*	Rodent <100g	**1**
Western jumping mouse	*Zapus princeps*	Rodent <100g	**1**
Pacific jumping mouse	*Zapus trinotatus*	Rodent <100g	**1**
Olive-backed pocket mouse	*Perognathus fasciatus*	Rodent <100g	**1**
Plains pocket mouse	*Perognathus flavescens*	Rodent <100g	**1**
Great Basin pocket mouse	*Perognathus parvus*	Rodent <100g	**1**
White-eared pocket mouse	*Perognathus alticola*	Rodent <100g	**1**
Silky pocket mouse	*Perognathus flavus*	Rodent <100g	**1**
Merriam's pocket mouse	*Perognathus merriami*	Rodent <100g	**1**
Little pocket mouse	*Perognathus longimembris*	Rodent <100g	**1**
Arizona pocket mouse	*Perognathus amplus*	Rodent <100g	**1**
San Joaquin pocket mouse	*Perognathus inornatus*	Rodent <100g	**1**
Mexican spiny pocket mouse	*Liomys irroratus*	Rodent <100g	**1**
Bailey's pocket mouse	*Chaetodipus baileyi*	Rodent <100g	**1**
Baja pocket mouse	*Chaetodipus rudinoris*	Rodent <100g	**1**
Hispid pocket mouse	*Chaetodipus hispidus*	Rodent <100g	**1**
Desert pocket mouse	*Chaetodipus penicillatus*	Rodent <100g	**1**
Chihuahuan pocket mouse	*Chaetodipus eremicus*	Rodent <100g	**1**
Rock pocket mouse	*Chaetodipus intermedius*	Rodent <100g	**1**
Nelson's pocket mouse	*Chaetodipus nelsoni*	Rodent <100g	**1**
San Diego pocket mouse	*Chaetodipus fallax*	Rodent <100g	**1**
California pocket mouse	*Chaetodipus californicus*	Rodent <100g	**1**
Spiny pocket mouse	*Chaetodipus spinatus*	Rodent <100g	**1**
Long-tailed pocket mouse	*Chaetodipus formosus*	Rodent <100g	**1**
Meadow vole	*Microtus pennsylvanicus*	Rodent <100g	**1**
Beach vole	*Microtus breweri*	Rodent <100g	**1**
Montane vole	*Microtus montanus*	Rodent <100g	**1**
Gray-tailed vole	*Microtus canicaudus*	Rodent <100g	**1**
California vole	*Microtus californicus*	Rodent <100g	**1**
Townsend's vole	*Microtus townsendii*	Rodent <100g	**1**

(*continued on next page*)

Rodents (Continued)			
Common Name	**Scientific Name**	**Guild (Mass)**	**Severity**
Tundra vole	*Microtus oeconomus*	Rodent <100g	**1**
Long-tailed vole	*Microtus longicaudus*	Rodent <100g	**1**
Creeping vole	*Microtus oregoni*	Rodent <100g	**1**
Rock vole	*Microtus chrotorrhinus*	Rodent <100g	**1**
Taiga vole	*Microtus xanthognathus*	Rodent <100g	**1**
Prairie vole	*Microtus ochrogaster*	Rodent <100g	**1**
Mexican vole	*Microtus mexicanus*	Rodent <100g	**1**
Woodland vole	*Microtus pinetorum*	Rodent <100g	**1**
Singing vole	*Microtus miurus*	Rodent <100g	**1**
Insular vole	*Microtus abbreviatus*	Rodent <100g	**1**
Water vole	*Microtus richardsoni*	Rodent <100g	**1**
Sagebrush vole	*Lemmiscus curtatus*	Rodent <100g	**1**
White-footed vole	*Arborimus albipes*	Rodent <100g	**1**
Red tree vole	*Arborimus longicaudus*	Rodent <100g	**1**
Sonoma tree vole	*Arborimus pomo*	Rodent <100g	**1**
Western heather vole	*Phenacomys intermedius*	Rodent <100g	**1**
Eastern heather vole	*Phenacomys ungava*	Rodent <100g	**1**
Western red-backed vole	*Myodes californicus*	Rodent <100g	**1**
Southern red-backed vole	*Myodes gapperi*	Rodent <100g	**1**
Northern red-backed vole	*Myodes rutilus*	Rodent <100g	**1**
Northern bog lemming	*Synaptomys borealis*	Rodent <100g	**1**
Southern bog lemming	*Synaptomys cooperi*	Rodent <100g	**1**
Brown lemming	*Lemmus trimucronatus*	Rodent <100g	**1**
Northern collared lemming	*Dicrostonyx groenlandicus*	Rodent <100g	**1**
Ungave collared lemming	*Dicrostonyx hudsonius*	Rodent <100g	**1**
Richardson's collared lemming	*Dicrostonyx richardsoni*	Rodent <100g	**1**
Northern pygmy mouse	*Baiomys taylori*	Rodent <100g	**1**
Golden mouse	*Ochrotomys nuttalli*	Rodent <100g	**1**
Cactus mouse	*Peromyscus eremicus*	Rodent <100g	**1**
Northern Baja mouse	*Peromyscus fraterculus*	Rodent <100g	**1**
Mesquite mouse	*Peromyscus merriami*	Rodent <100g	**1**
California mouse	*Peromyscus californicus*	Rodent <100g	**1**
Oldfield mouse	*Peromyscus polionotus*	Rodent <100g	**1**
Keen's mouse	*Peromyscus keeni*	Rodent <100g	**1**
American deer mouse	*Peromyscus maniculatus*	Rodent <100g	**1**
White-footed mouse	*Peromyscus leucopus*	Rodent <100g	**1**
Cotton mouse	*Peromyscus gossypinus*	Rodent <100g	**1**
Canyon mouse	*Peromyscus crinitus*	Rodent <100g	**1**

(*continued on next page*)

Rodents (Continued)			
Common Name	**Scientific Name**	**Guild (Mass)**	**Severity**
White-ankled mouse	*Peromyscus pectoralis*	Rodent <100g	**1**
Brush mouse	*Peromyscus boylii*	Rodent <100g	**1**
Texas mouse	*Peromyscus attwateri*	Rodent <100g	**1**
Pinon mouse	*Peromyscus truei*	Rodent <100g	**1**
Osgood's mouse	*Peromyscus gratus*	Rodent <100g	**1**
Northern pocket mouse	*Peromyscus nasutus*	Rodent <100g	**1**
Florida mouse	*Podomys floridanus*	Rodent <100g	**1**
Plains harvest mouse	*Reithrodontomys montanus*	Rodent <100g	**1**
Eastern harvest mouse	*Reithrodontomys humulis*	Rodent <100g	**1**
Western harvest mouse	*Reithrodontomys megalotis*	Rodent <100g	**1**
Salt-marsh harvest mouse	*Reithrodontomys raviventris*	Rodent <100g	**1**
Fulvous harvest mouse	*Reithrodontomys fulvescens*	Rodent <100g	**1**
Northern grasshopper mouse	*Onychomys leucogaster*	Rodent <100g	**1**
Southern grasshopper mouse	*Onychomys torridus*	Rodent <100g	**1**
Mearn's grasshopper mouse	*Onychomys arenicola*	Rodent <100g	**1**
House mouse	*Mus musculus*	Rodent <100g	**1**
Northern short-tailed shrew	*Blarina brevicauda*	Rodent <100g	**1**
Southern short-tailed shrew	*Blarina carolinensis*	Rodent <100g	**1**
Elliot's short-tailed shrew	*Blarina hylophaga*	Rodent <100g	**1**
Least shrew	*Cryptotis parva*	Rodent <100g	**1**
Desert shrew	*Notiosorex crawfordi*	Rodent <100g	**1**
Arctic shrew	*Sorex arcticus*	Rodent <100g	**1**
Maritime shrew	*Sorex maritimensis*	Rodent <100g	**1**
Tundra shrew	*Sorex tundrensis*	Rodent <100g	**1**
Alaska tiny shrew	*Sorex yukonicus*	Rodent <100g	**1**
Marsh shrew	*Sorex bendirii*	Rodent <100g	**1**
American water shrew	*Sorex palustris*	Rodent <100g	**1**
Smoky shrew	*Sorex fumeus*	Rodent <100g	**1**
Rock shrew	*Sorex dispar*	Rodent <100g	**1**
Gaspe shrew	*Sorex gaspensis*	Rodent <100g	**1**
Barren ground shrew	*Sorex ugyunak*	Rodent <100g	**1**
Saint Lawrence Island shrew	*Sorex jacksoni*	Rodent <100g	**1**
Pribilof Island shrew	*Sorex hydrodromus*	Rodent <100g	**1**

(*continued on next page*)

Rodents (Continued)			
Common Name	**Scientific Name**	**Guild (Mass)**	**Severity**
Masked shrew	*Sorex cinereus*	Rodent <100g	**1**
Hayden's shrew	*Sorex haydeni*	Rodent <100g	**1**
Mount Lyell shrew	*Sorex lyelli*	Rodent <100g	**1**
Southeastern shrew	*Sorex longirostris*	Rodent <100g	**1**
Preble's shrew	*Sorex preblei*	Rodent <100g	**1**
Pacific shrew	*Sorex pacificus*	Rodent <100g	**1**
Fog shrew	*Sorex sonomae*	Rodent <100g	**1**
Baird's shrew	*Sorex bairdi*	Rodent <100g	**1**
Montane shrew	*Sorex monticolus*	Rodent <100g	**1**
New Mexico shrew	*Sorex neomexicanus*	Rodent <100g	**1**
Vagrant shrew	*Sorex vagrans*	Rodent <100g	**1**
Ornate shrew	*Sorex ornatus*	Rodent <100g	**1**
Dwarf shrew	*Sorex nanus*	Rodent <100g	**1**
Inyo shrew	*Sorex tenellus*	Rodent <100g	**1**
Pygmy shrew	*Sorex hoyi*	Rodent <100g	**1**
Arizona shrew	*Sorex arizonae*	Rodent <100g	**1**
Merriam's shrew	*Sorex merriami*	Rodent <100g	**1**
Trowbridge's shrew	*Sorex trowbridgii*	Rodent <100g	**1**
Yellow-faced pocket gopher	*Cratogeomys castanops*	Rodent 100-599g	**2**
Southeastern pocket gopher	*Geomys pinetis*	Rodent 100-599g	**2**
Desert pocket gopher	*Geomys arenarius*	Rodent 100-599g	**2**
Plains pocket gopher	*Geomys bursarius*	Rodent 100-599g	**2**
Jones's pocket gopher	*Geomys knoxjonesi*	Rodent 100-599g	**2**
Texas pocket gopher	*Geomys personatus*	Rodent 100-599g	**2**
Baird's pocket gopher	*Geomys breviceps*	Rodent 100-599g	**2**
Llano pocket gopher	*Geomys texensis*	Rodent 100-599g	**2**
Attwater's pocket gopher	*Geomys attwateri*	Rodent 100-599g	**2**
Northern pocket gopher	*Thomomys talpoides*	Rodent 100-599g	**2**
Western pocket gopher	*Thomomys mazama*	Rodent 100-599g	**2**
Botta's pocket gopher	*Thomomys bottae*	Rodent 100-599g	**2**
Southern pocket gopher	*Thomomys umbrinus*	Rodent 100-599g	**2**
Wyoming pocket gopher	*Thomomys clusius*	Rodent 100-599g	**2**
Idaho pocket gopher	*Thomomys idahoensis*	Rodent 100-599g	**2**
Mountain pocket gopher	*Thomomys monticola*	Rodent 100-599g	**2**
Townsend's pocket gopher	*Thomomys townsendii*	Rodent 100-599g	**2**
Camas pocket gopher	*Thomomys bulbivorus*	Rodent 100-599g	**2**
Ord's kangaroo rat	*Dipodomys ordii*	Rodent 100-599g	**2**

(*continued on next page*)

Rodents (Continued)			
Common Name	**Scientific Name**	**Guild (Mass)**	**Severity**
Gulf Coast kangaroo rat	*Dipodomys compactus*	Rodent 100-599g	**2**
Chisel-toothed kangaroo rat	*Dipodomys microps*	Rodent 100-599g	**2**
Panamint kangaroo rat	*Dipodomys panamintinus*	Rodent 100-599g	**2**
Stephen's kangaroo rat	*Dipodomys stephensi*	Rodent 100-599g	**2**
Narrow- faced kangaroo rat	*Dipodomys venustus*	Rodent 100-599g	**2**
Agile kangaroo rat	*Dipodomys agilis*	Rodent 100-599g	**2**
Dulzura kangaroo rat	*Dipodomys simulans*	Rodent 100-599g	**2**
California kangaroo rat	*Dipodomys californicus*	Rodent 100-599g	**2**
Heermann's kangaroo rat	*Dipodomys heermanni*	Rodent 100-599g	**2**
Giant kangaroo rat	*Dipodomys ingens*	Rodent 100-599g	**2**
Banner-tailed kangaroo rat	*Dipodomys spectabilis*	Rodent 100-599g	**2**
Texas kangaroo rat	*Dipodomys elator*	Rodent 100-599g	**2**
Desert kangaroo rat	*Dipodomys deserti*	Rodent 100-599g	**2**
Merriam's kangaroo rat	*Dipodomys merriami*	Rodent 100-599g	**2**
San Joaquin kangaroo rat	*Dipodomys nitratoides*	Rodent 100-599g	**2**
Dark kangaroo mouse	*Microdipodops megacephalus*	Rodent 100-599g	**2**
Pale kangaroo mouse	*Microdipodops pallidus*	Rodent 100-599g	**2**
Northern flying squirrel	*Glaucomys sabrinus*	Rodent 100-599g	**2**
Southern flying squirrel	*Glaucomys volans*	Rodent 100-599g	**2**
Harris's antelope squirrel	*Ammospermophilus harrisii*	Rodent 100-599g	**2**
White-tailed antelope squirrel	*Ammospermophilus leucurus*	Rodent 100-599g	**2**
Texas antelope squirrel	*Ammospermophilus interpres*	Rodent 100-599g	**2**
Nelson's antelope squirrel	*Ammospermophilus nelsoni*	Rodent 100-599g	**2**
Rock Squirrel	*Otospermophilus variegatus*	Rodent 100-599g	**2**
Golden-mantled ground squirrel	*Callospermophilus lateralis*	Rodent 100-599g	**2**
Cascade ground squirrel	*Callospermophilus saturatus*	Rodent 100-599g	**2**
Mohave ground squirrel	*Xerospermophilus mohavensis*	Rodent 100-599g	**2**
Spotted ground squirrel	*Xerospermophilus spilosoma*	Rodent 100-599g	**2**
Round-tailed ground squirrel	*Xerospermophilus tereticaudus*	Rodent 100-599g	**2**

(*continued on next page*)

Rodents (Continued)			
Common Name	**Scientific Name**	**Guild (Mass)**	**Severity**
Franklin's ground squirrel	*Poliocitellus franklinii*	Rodent 100-599g	**2**
Thirteen-lined ground squirrel	*Ictidomys tridecemlineatus*	Rodent 100-599g	**2**
Mexican ground squirrel	*Ictidomys mexicanus*	Rodent 100-599g	**2**
Townsend's ground squirrel	*Urocitellus townsendii*	Rodent 100-599g	**2**
Great Basin ground squirrel	*Urocitellus mollis*	Rodent 100-599g	**2**
Columbia Plateau ground squirrel	*Urocitellus canus*	Rodent 100-599g	**2**
Washington ground squirrel	*Urocitellus washingtoni*	Rodent 100-599g	**2**
Idaho ground squirrel	*Urocitellus richardsonii*	Rodent 100-599g	**2**
Wyoming ground squirrel	*Urocitellus elegans*	Rodent 100-599g	**2**
Uinta ground squirrel	*Urocitellus armatus*	Rodent 100-599g	**2**
Belding's ground squirrel	*Urocitellus beldingi*	Rodent 100-599g	**2**
Columbian ground squirrel	*Urocitellus columbianus*	Rodent 100-599g	**2**
Arctic ground squirrel	*Urocitellus parryii*	Rodent 100-599g	**2**
California ground squirrel	*Urocitellus beecheyi*	Rodent 100-599g	**2**
Eastern chipmunk	*Tamias striatus*	Rodent 100-599g	**2**
Alpine chipmunk	*Tamias alpinus*	Rodent 100-599g	**2**
Least chipmunk	*Tamias minimus*	Rodent 100-599g	**2**
Yellow-pine chipmunk	*Tamias amoenus*	Rodent 100-599g	**2**
Townsend's chipmunk	*Tamias townsendii*	Rodent 100-599g	**2**
Allen's chipmunk	*Tamias senex*	Rodent 100-599g	**2**
Yellow-cheeked chipmunk	*Tamias ochrogenys*	Rodent 100-599g	**2**
Siskiyou chipmunk	*Tamias siskiyou*	Rodent 100-599g	**2**
Sonoma chipmunk	*Tamias sonomae*	Rodent 100-599g	**2**
Merriam's chipmunk	*Tamias merriami*	Rodent 100-599g	**2**
California chipmunk	*Tamias obscurus*	Rodent 100-599g	**2**
Cliff chipmunk	*Tamias dorsalis*	Rodent 100-599g	**2**
Colorado chipmunk	*Tamias quadrivittatus*	Rodent 100-599g	**2**
Hopi chipmunk	*Tamias rufus*	Rodent 100-599g	**2**
Red-tailed chipmunk	*Tamias ruficaudus*	Rodent 100-599g	**2**
Gray-footed chipmunk	*Tamias canipes*	Rodent 100-599g	**2**
Gray-collared chipmunk	*Tamias cinereicollis*	Rodent 100-599g	**2**
Long-eared chipmunk	*Tamias quadrimaculatus*	Rodent 100-599g	**2**
Lodgepole chipmunk	*Tamias speciosus*	Rodent 100-599g	**2**
Panamint chipmunk	*Tamias panamintinus*	Rodent 100-599g	**2**
Uinta chipmunk	*Tamias umbrinus*	Rodent 100-599g	**2**
Palmer's chipmunk	*Tamias palmeri*	Rodent 100-599g	**2**

(*continued on next page*)

Rodents (Continued)			
Common Name	**Scientific Name**	**Guild (Mass)**	**Severity**
Red squirrel	*Tamiasciurus hudsonicus*	Rodent 100-599g	**2**
Douglas's squirrel	*Tamiasciurus douglasii*	Rodent 100-599g	**2**
Coues's rice rat	*Oryzomys couesi*	Rodent 100-599g	**2**
Marsh rice rat	*Oryzomys palustris*	Rodent 100-599g	**2**
Hispid cotton rat	*Sigmodon hispidus*	Rodent 100-599g	**2**
Arizona cotton rat	*Sigmodon arizonae*	Rodent 100-599g	**2**
Tawny-bellied cotton rat	*Sigmodon fulviventer*	Rodent 100-599g	**2**
Yellow-nosed cotton rat	*Sigmodon ochrognathus*	Rodent 100-599g	**2**
Black rat	*Rattus rattus*	Rodent 100-599g	**2**
Norway rat	*Rattus norvegicus*	Rodent 100-599g	**2**
American shrew mole	*Neurotrichus gibbsii*	Rodent 100-599g	**2**
Broad-footed mole	*Scapanus latimanus*	Rodent 100-599g	**2**
Coast mole	*Scapanus orarius*	Rodent 100-599g	**2**
Townsend's mole	*Scapanus townsendii*	Rodent 100-599g	**2**
Hairy-tailed mole	*Parascalops breweri*	Rodent 100-599g	**2**
Eastern mole	*Scalopus aquaticus*	Rodent 100-599g	**2**
Star-nosed mole	*Condylura cristata*	Rodent 100-599g	**2**
Aplodontia	*Aplodontia rufa*	Rodent 600-1999g	**3**
Eastern gray squirrel	*Sciurus carolinensis*	Rodent 600-1999g	**3**
Red-bellied squirrel	*Sciurus aureogaster*	Rodent 600-1999g	**3**
Eastern fox squirrel	*Sciurus niger*	Rodent 600-1999g	**3**
Mexican fox squirrel	*Sciurus nayaritensis*	Rodent 600-1999g	**3**
Arizona gray squirrel	*Sciurus arizonensis*	Rodent 600-1999g	**3**
Western gray squirrel	*Sciurus griseus*	Rodent 600-1999g	**3**
Abert's squirrel	*Sciurus aberti*	Rodent 600-1999g	**3**
Black-tailed prairie dog	*Cynomys ludovicianus*	Rodent 600-1999g	**3**
White-tailed prairie dog	*Cynomys leucurus*	Rodent 600-1999g	**3**
Utah prairie dog	*Cynomys parvidens*	Rodent 600-1999g	**3**
Gunnison's prairie dog	*Cynomys gunnisoni*	Rodent 600-1999g	**3**
Eastern woodrat	*Neotoma floridana*	Rodent 600-1999g	**3**
Allegheny woodrat	*Neotoma magister*	Rodent 600-1999g	**3**
Southern Plains woodrat	*Neotoma micropus*	Rodent 600-1999g	**3**
Western white-throated woodrat	*Neotoma albigula*	Rodent 600-1999g	**3**
Eastern white-throated woodrat	*Neotoma leucodon*	Rodent 600-1999g	**3**
Desert woodrat	*Neotoma lepida*	Rodent 600-1999g	**3**
Arizona woodrat	*Neotoma devia*	Rodent 600-1999g	**3**
Stephens's woodrat	*Neotoma stephensi*	Rodent 600-1999g	**3**
Mexican woodrat	*Neotoma mexicana*	Rodent 600-1999g	**3**

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Rodents (Continued)			
Common Name	**Scientific Name**	**Guild (Mass)**	**Severity**
Dusky-footed woodrat	*Neotoma fuscipes*	Rodent 600-1999g	**3**
Big-eared woodrat	*Neotoma macrotis*	Rodent 600-1999g	**3**
Bushy-tailed woodrat	*Neotoma cinerea*	Rodent 600-1999g	**3**
Woodchuck	*Marmota monax*	Rodent 2000-9999g	**4**
Yellow-bellied marmot	*Marmota flaviventris*	Rodent 2000-9999g	**4**
Hoary marmot	*Marmota caligata*	Rodent 2000-9999g	**4**
Alaska marmot	*Marmota broweri*	Rodent 2000-9999g	**4**
Olympic Marmot	*Marmota olympus*	Rodent 2000-9999g	**4**
Vancouver Island marmot	*Marmota vancouverensis*	Rodent 2000-9999g	**4**
Round-tailed muskrat	*Neofiber alleni*	Rodent 2000-9999g	**4**
Common muskrat	*Ondatra zibethicus*	Rodent 2000-9999g	**4**
Nutria	*Myocastor coypus*	Rodent 2000-9999g	**4**
American beaver	*Castor canadensis*	Rodent >10000g	**5**
North American porcupine	*Erethizon dorsatum*	Rodent >10000g	**5**
Lagomorphs			
Common Name	**Scientific Name**	**Guild (Mass)**	**Severity**
Collared pika	*Ochotona collaris*	Lagomorph 100-599g	**2**
American pika	*Ochotona princeps*	Lagomorph 100-599g	**2**
Pygmy rabbit	*Brachylagus idahoensis*	Lagomorph 100-599g	**2**
Brush rabbit	*Sylvilagus bachmani*	Lagomorph 2000-9999g	**4**
Swamp rabbit	*Sylvilagus aquaticus*	Lagomorph 2000-9999g	**4**
Marsh rabbit	*Sylvilagus palustris*	Lagomorph 2000-9999g	**4**
Eastern cottontail	*Sylvilagus floridanus*	Lagomorph 2000-9999g	**4**
New England cottontail	*Sylvilagus transitionalis*	Lagomorph 2000-9999g	**4**
Appalachian cottontail	*Sylvilagus obscurus*	Lagomorph 2000-9999g	**4**
Mountain cottontail	*Sylvilagus nuttallii*	Lagomorph 2000-9999g	**4**
Desert cottontail	*Sylvilagus audubonii*	Lagomorph 2000-9999g	**4**
European rabbit	*Oryctolagus cuniculus*	Lagomorph 2000-9999g	**4**
Snowshoe hare	*Lepus americanus*	Lagomorph 2000-9999g	**4**
Alaskan hare	*Lepus othus*	Lagomorph 2000-9999g	**4**
Arctic hare	*Lepus arcticus*	Lagomorph 2000-9999g	**4**
White-tailed jackrabbit	*Lepus townsendii*	Lagomorph 2000-9999g	**4**
Black-tailed jackrabbit	*Lepus californicus*	Lagomorph 2000-9999g	**4**
White-sided jackrabbit	*Lepus callotis*	Lagomorph 2000-9999g	**4**
Antelope jackrabbit	*Lepus alleni*	Lagomorph 2000-9999g	**4**
European hare	*Lepus capensis*	Lagomorph 2000-9999g	**4**

(*continued on next page*)

Bats			
Common Name	**Scientific Name**	**Guild (Mass)**	**Severity**
Western pipistrelle	*Pipistrellus hesperus*	Bats <100g	**1**
Eastern pipistrelle	*Pipistrellus subflavus*	Bats <100g	**1**
Big brown bat	*Eptesicus fuscus*	Bats <100g	**1**
Evening bat	*Nycticeius humeralis*	Bats <100g	**1**
Southern yellow bat	*Lasiurus ega*	Bats <100g	**1**
Western yellow bat	*Lasiurus xanthinus*	Bats <100g	**1**
Northern yellow bat	*Lasiurus intermedius*	Bats <100g	**1**
Eastern red bat	*Lasiurus borealis*	Bats <100g	**1**
Western red bat	*Lasiurus blossevillii*	Bats <100g	**1**
Seminole bat	*Lasiurus seminolus*	Bats <100g	**1**
Hoary bat	*Lasiurus cinereus*	Bats <100g	**1**
Spotted bat	*Euderma maculatum*	Bats <100g	**1**
Rafinesque's big-eared bat	*Corynorhinus rafinesquii*	Bats <100g	**1**
Townsend's big-eared bat	*Corynorhinus townsendii*	Bats <100g	**1**
California myotis	*Myotis californicus*	Bats <100g	**1**
Western small-footed myotis	*Myotis ciliolabrum*	Bats <100g	**1**
Eastern small-footed myotis	*Myotis leibii*	Bats <100g	**1**
Yuma myotis	*Myotis yumanensis*	Bats <100g	**1**
Little brown bat	*Myotis lucifugus*	Bats <100g	**1**
Arizona myotis	*Myotis occultus*	Bats <100g	**1**
Indiana myotis	*Myotis sodalis*	Bats <100g	**1**
Southeastern myotis	*Myotis austroriparius*	Bats <100g	**1**
Cave myotis	*Myotis velifer*	Bats <100g	**1**
Gray myotis	*Myotis grisescens*	Bats <100g	**1**
Long-legged myotis	*Myotis volans*	Bats <100g	**1**
Northern myotis	*Myotis septentrionalis*	Bats <100g	**1**
Southwestern myotis	*Myotis auriculus*	Bats <100g	**1**
Long-eared myotis	*Myotis evotis*	Bats <100g	**1**
Keen's myotis	*Myotis keenii*	Bats <100g	**1**
Fringed myotis	*Myotis thysanodes*	Bats <100g	**1**
Florida bonneted bat	*Eumops floridanus*	Bats <100g	**1**
Western bonneted bat	*Eumops perotis*	Bats <100g	**1**
Underwood's bonneted bat	*Eumops underwoodi*	Bats <100g	**1**
Little mastiff bat	*Molossus molossus*	Bats <100g	**1**
Pocketed free-tailed bat	*Nyctinomops femorosaccus*	Bats <100g	**1**
Big free-tailed bat	*Nyctinomops macrotis*	Bats <100g	**1**

(*continued on next page*)

Bats (Continued)			
Common Name	**Scientific Name**	**Guild (Mass)**	**Severity**
Brazilian free-tailed bat	*Tadarida brasiliensis*	Bats <100g	**1**
Pallid bat	*Antrozous pallidus*	Bats <100g	**1**
Peter's ghost-faced bat	*Mormoops megalophylla*	Bats <100g	**1**
California leaf-nosed bat	*Macrotus californicus*	Bats <100g	**1**
Silver-haired bat	*Lasionycteris noctivagans*	Bats <100g	**1**
Allen's big-eared bat	*Idionycteris phyllotis*	Bats <100g	**1**
Cuban flower bat	*Phyllonycteris poeyi*	Bats 100-599g	**2**
Buffy flower bat	*Erophylla sezekorni*	Bats 100-599g	**2**
Hairy-legged vampire bat	*Diphylla ecaudata*	Bats 100-599g	**2**
Lesser long-nosed bat	*Leptonycteris yerbabuenae*	Bats 100-599g	**2**
Mexican long-nosed bat	*Leptonycteris nivalis*	Bats 100-599g	**2**
Mexican long-tongued bat	*Choeronycteris mexicana*	Bats 100-599g	**2**
Jamaican fruit-eating bat	*Artibeus jamaicensis*	Bats 100-599g	**2**
Cuban fig-eating bat	*Phyllops falcatus*	Bats 100-599g	**2**
Mesomammals			
Common Name	**Scientific Name**	**Guild (Mass)**	**Severity**
Western spotted skunk	*Spilogale gracilis*	Mesomammals 100-599g	**2**
Eastern spotted skunk	*Spilgale putorius*	Mesomammals 100-599g	**2**
Least weasel	*Mustela nivalis*	Mesomammals 100-599g	**2**
Short-tailed weasel	*Mustela erminea*	Mesomammals 100-599g	**2**
Long-tailed weasel	*Mustela frenata*	Mesomammals 100-599g	**2**
American mink	*Mustela vison*	Mesomammals 100-599g	**2**
Striped skunk	*Mephitis mephitis*	Mesomammals 600-1999g	**3**
Hooded skunk	*Mephitis macroura*	Mesomammals 600-1999g	**3**
Black-footed ferret	*Mustela nigripes*	Mesomammals 600-1999g	**3**
Virginia opossum	*Didelphis virginiana*	Mesomammals 2000-9999g	**4**
Nine-banded armadillo	*Dasypus novemcinctus*	Mesomammals 2000-9999g	**4**
Ringtail	*Bassariscus astutus*	Mesomammals 2000-9999g	**4**
Northern raccoon	*Procyon lotor*	Mesomammals 2000-9999g	**4**
White-nosed coati	*Nasua narica*	Mesomammals 2000-9999g	**4**
White-backed hog-nosed skunk	*Conepatus leuconotus*	Mesomammals 2000-9999g	**4**

(*continued on next page*)

Mesomammals (Continued)			
Common Name	**Scientific Name**	**Guild (Mass)**	**Severity**
Fisher	*Martes pennanti*	Mesomammals 2000-9999g	**4**
American marten	*Martes americana*	Mesomammals >10000g	**5**
Wolverine	*Gulo gulo*	Mesomammals >10000g	**5**
American badger	*Taxidea taxus*	Mesomammals >10000g	**5**
Northern river otter	*Lontra canadensis*	Mesomammals >10000g	**5**
Canids			
Common Name	**Scientific Name**	**Guild (Mass)**	**Severity**
Domestic/Feral Dog	*Canis familiiaris*	Canids 2000-9999g	**4**
Arctic fox	*Alopex lagopus*	Canids 2000-9999g	**4**
Swift fox	*Vulpes velox*	Canids 2000-9999g	**4**
Kit fox	*Vulpes macrotis*	Canids 2000-9999g	**4**
Red fox	*Vulpes vulpes*	Canids 2000-9999g	**4**
Gray fox	*Urocyon cinereoargenteus*	Canids 2000-9999g	**4**
Island gray fox	*Urocyon littoralis*	Canids 2000-9999g	**4**
Coyote	*Canis latrans*	Canids >10000g	**5**
Gray wolf	*Canis lupus*	Canids >10000g	**5**
Eastern timber wolf	*Canis lycaon*	Canids >10000g	**5**
Red Wolf	*Canis rufus*	Canids >10000g	**5**
Felids			
Common Name	**Scientific Name**	**Guild (Mass)**	**Severity**
Domestic/Feral Cat	*Felis catus*	Felids 600-1999g	**3**
Cougar	*Puma concolor*	Felids >10000g	**5**
Ocelot	*Leopardus pardalis*	Felids >10000g	**5**
Jaguarundi	*Herpailurus yagouaroundi*	Felids >10000g	**5**
Bobcat	*Lynx rufus*	Felids >10000g	**5**
Canada lynx	*Lynx canadensis*	Felids >10000g	**5**
Jaguar	*Panthera onca*	Felids >10000g	**5**
Hooved			
Common Name	**Scientific Name**	**Guild (Mass)**	**Severity**
Wild boar	*Sus scrofa*	Hooved >10000g	**5**
Collared peccary	*Tayassu tajacu*	Hooved >10000g	**5**
Elk	*Cervus elaphus*	Hooved >10000g	**5**
Sika deer	*Cervus nippon*	Hooved >10000g	**5**
Sambar deer	*Cervus unicolor*	Hooved >10000g	**5**
Axis deer	*Axis axis*	Hooved >10000g	**5**
Fallow deer	*Dama dama*	Hooved >10000g	**5**

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Hooved (Continued)			
Common Name	**Scientific Name**	**Guild (Mass)**	**Severity**
White-tailed deer	*Odocoileus virginianus*	Hooved >10000g	**5**
Mule deer	*Odocoileus hemionus*	Hooved >10000g	**5**
Moose	*Alces alces*	Hooved >10000g	**5**
Caribou	*Rangifer tarandus*	Hooved >10000g	**5**
Pronghorn	*Antilocapra americana*	Hooved >10000g	**5**
Nilgai	*Boselaphus tragocamelus*	Hooved >10000g	**5**
American bison	*Bos bison*	Hooved >10000g	**5**
Blackbuck	*Antilope cervicapra*	Hooved >10000g	**5**
Mountain goat	*Oreamnos americanus*	Hooved >10000g	**5**
Muskox	*Ovibos moschatus*	Hooved >10000g	**5**
Barbary sheep	*Ammotragus lervia*	Hooved >10000g	**5**
Bighorn sheep	*Ovis canadensis*	Hooved >10000g	**5**
Dall's sheep	*Ovis dalli*	Hooved >10000g	**5**
European mouflon	*Ovis musimon*	Hooved >10000g	**5**
Feral Donkey	*Equus asinus*	Hooved >10000g	**5**
Feral Horse	*Equus ferus*	Hooved >10000g	**5**
Bears			
Common Name	**Scientific Name**	**Guild (Mass)**	**Severity**
Black bear	*Ursus americanus*	Bears >10000g	**5**
Brown bear	*Ursus arctos*	Bears >10000g	**5**
Polar bear	*Ursus maritimus*	Bears >10000g	**5**

Attachment 10: Technical Aspects of the WHaMRAT

10.1 Overview

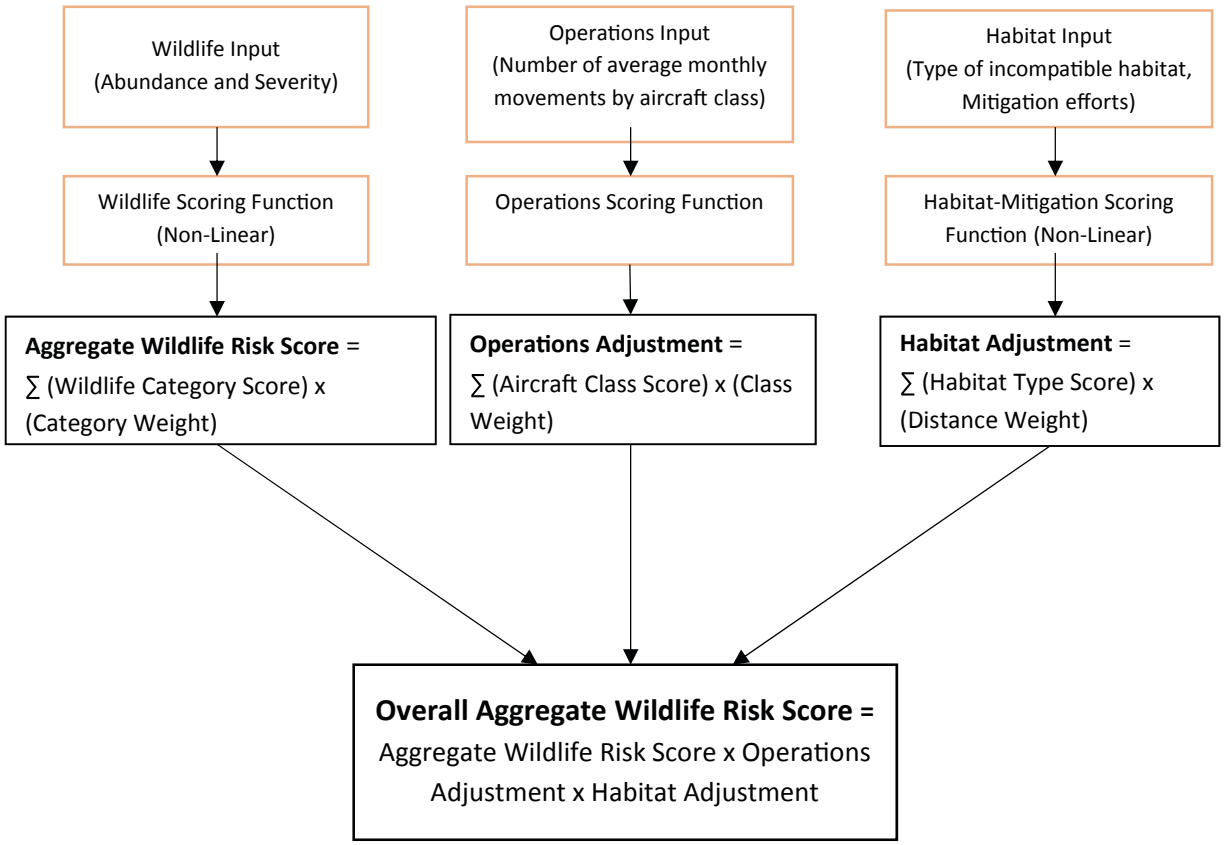
The Wildlife Hazard Management Risk Assessment Tool (WHaMRAT) is a decision support tool to assist airports in identifying and mitigating the risk associated with wildlife present during aircraft operations. It is built upon a Multi-Attribute Decision Making (MADM) framework, taking wildlife abundance (likelihood of strike), aircraft operations class and tempo, habitat on and surrounding the airport, and the mitigation techniques and efforts employed to reduce the impact of habitat as well as mitigation efforts against wildlife guilds and species, as input and produces an overall risk score for the airport presented both numerically and graphically.

10.2 Basic Design

The WHaMRAT contains three user-input Worksheets: 1) a Wildlife Data Worksheet; 2) an Operations Data Worksheet; and 3) a Habitat and Mitigation Worksheet. The Wildlife Data Worksheet produces a score that is a linear combination of the Avian wildlife score, the Mammalian wildlife score, and the Reptilian wildlife score. The user inputs are the abundance of each guild or species of wildlife and the severity index (built into the WHaMRAT, not changeable by the user) for each guild. The cumulative severity and likelihood of strike for all guilds results in the Aggregate Wildlife Risk Score. The Operations Data Worksheet produces a score that is the linear combination of scores for five aircraft classes: Commercial, Air Taxi, General Aviation, Military, and Rotary. These scores are based upon monthly average aircraft movements and susceptibility to strike damage by aircraft type for each class of aircraft. The Habitat and Mitigation Worksheet produces a habitat score that is a linear combination of habitat on and around the airport adjusted for distance from airport operations. Additionally, this habitat score is decreased based upon the level of habitat mitigation efforts targeting each habitat. The user will input the incompatible habitat for the airport at the appropriate distance from airport operations. The additional modeling of wildlife mitigation against specific guilds and species in this module is used for the future-projected results in that the current mitigation efforts are reflected in current wildlife abundance measures. The Aggregate Wildlife Risk Score in the WHaMRAT is the basis for the risk assessment. This score is then multiplied by the Operations Data Adjustment, and then by the Habitat and Mitigation Adjustments to produce the Overall Aggregate Wildlife Risk Score.

Each Worksheet has various components that break down the Worksheet into classes. For example, the Wildlife Data Worksheet contains the Avian, Mammalian, and Reptilian guilds. The Operations Data Worksheet has the Commercial, Air Taxi, General Aviation, Military, and Rotary aircraft classes, and the Habitat and Mitigation Worksheet has classes based upon 15 habitats that are listed by the FAA as being incompatible with airport operations plus possible additional user-defined habitats. Each component is assessed a risk score using a non-linear scoring function and then this risk score is linearly combined with the weights for each category to calculate an overall risk score for that module. The Aggregate Wildlife Risk Score is then multiplied by the Operations Data Adjustment and by the Habitat and Mitigation Adjustments to produce the Overall Aggregate Wildlife Risk Score. Figure 25 shows the graphical design of the tool.

Figure 25: Graphical Representation of the Tool Design



10.3 Overall Assumptions and Design Considerations

There are some overall assumptions that affect the design of the model/tool. These are listed and discussed below:

- **Risk is a function of wildlife body mass of wildlife on and around the airport.** The wildlife risk to airport operations is made up of two factors: the amount of wildlife on the airport (more wildlife equates to a higher probability of strike), and the relative body mass of the wildlife (higher mass equates to a potentially more damaging strike). This means that a higher amount of small wildlife could pose less risk than a smaller amount of large wildlife. For example, 300 hummingbirds that may average 3g in mass (total of 900g of biomass), are less of a risk than 20 Canada Geese that average 4500g in mass (total of 90,000g or 90Kg of biomass, or 100 times the total biomass of the hummingbirds). In general, the higher the total biomass of wildlife on the airport, the greater the risk.
- **The risk associated with wildlife on and around an airport is a non-linear function.** As wildlife occupy habitat on and around an airport, the risk at first increases quickly. However, there is a point where there is enough wildlife biomass on the airport such that the risk increases at a lesser rate with the increase in wildlife. Eventually, the risk becomes so high that adding more wildlife has a much smaller effect on the overall risk.

- **Risk increases with the number of monthly average aircraft movements.** The more aircraft movements (takeoffs and landings) the higher the chance of a wildlife strike because more movements could mean a longer operational time and movements during times of day with higher wildlife activity (dawn and dusk). Additionally, it is self-evident that more takeoffs and landings equates to a higher probability that a wildlife strike could occur as there are more opportunities for wildlife to be struck.
- **The risk adjustment for aircraft operations on an airport is a non-linear function.** If there are no airport operations, there is no risk. The risk increases quickly with an increase in aircraft movements, but at some point the increase in risk starts to decrease and level off. This is due to consistent, frequent aircraft movements acting as a deterrent to some wildlife and keeping them away from airport operations, as well as the increase in the amount of airport deterrent measures with larger airports supporting more operations. Data from large airports with significant aircraft movements per month support this assumption.
- **The more suitable wildlife habitat on and around the airport that attracts wildlife the higher the risk. In addition, the closer that habitat is to airport operations the greater the risk.** Incompatible habitats as listed in FAA Circular 150/5200-33B are considered to attract wildlife and increase airport operations risk. Habitat mitigation will decrease the risk. Habitat that is close to airport operations increases the likelihood of a strike at a critical time in an aircraft's flight, take-off and landing, and therefore, has a greater impact on risk than incompatible habitat farther away from the operating surfaces.
- **The risk adjustment for habitat is a linear combination of the number of habitats that exist at certain distances from the airport.** Wildlife strike data indicates that the risk for habitat decreases the farther the habitat is from airport operations. Thus, the assumption was made that the risk for habitat is a decreasing linear function relative to the distance from the airport.
- **All incompatible habitat types equally affect the risk.** While certain habitats attract wildlife with higher severity, those same habitats attract lower severity wildlife as well. Categorizing habitat into higher severity and lower severity was not possible due to too many of the incompatible habitats attracting both classes of wildlife. Thus, treating each habitat type as having an equal impact upon risk was necessary.

10.4 Wildlife Data Worksheet

Overview: The Wildlife Data Worksheet takes the user input of likelihood of strike and the system parameter of severity for each wildlife species and calculates the risk to aircraft operations due to wildlife on and around the airport. The results are presented by wildlife class (Avian, Mammalian, and Reptilian) and Aggregate Wildlife Risk Score. This risk result is a number between 0 and 5 inclusive with 5 being the highest risk and 0 being no risk.

Input: Likelihood of Strike for each species (user input) and species presence. Severity is based upon wildlife body mass and is not user changeable.

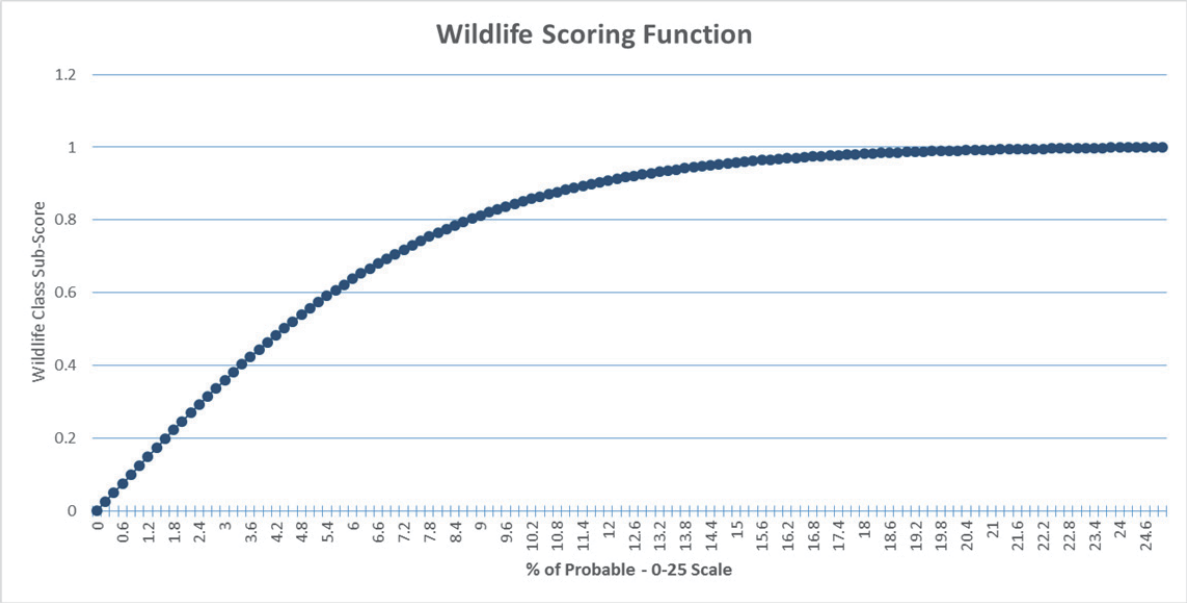
Output: Risk scores by wildlife class (Avian, Mammalian, and Reptilian), Aggregate Wildlife Risk Score, Risk level assessment (Low, Moderate, or High).

Algorithm:

- Multiply Likelihood of Strike input by Severity parameter for each species present to obtain the Risk Number [Risk Number = Likelihood of Strike x Severity].
- Sum the Risk numbers across species for each wildlife class (Avian, Mammalian, Reptilian) to obtain the Class Risk Score [Class Risk Score = Sum (All Species Risk Numbers by guild)].
- Calculate the highest probable Class Risk Score given wildlife guild and species on the airport for each wildlife guild. [Highest Probable Class Score = Sum over all guilds in a wildlife class of (Maximum Possible Likelihood x Max(Highest severity rating in a guild, Sum of the severity ratings of the wildlife present on the airport in a guild))]. Note: the maximum possible likelihood = 5.
- Divide the Class Risk Score for each class by the Highest Probable Class Score to obtain the % of Probable.
- Calculate the Wildlife Class sub-score by scaling the % of Probable to a 0-25 scale and using that as input to the scaling function. Scaling function output is on the interval [0,1]. [Scaling function TANH(%Probable/6.25)/0.9993293].
- Multiply the result of the scaling function for each wildlife class by the weighting value to obtain the Wildlife Class Risk Score for each class. [Wildlife Class Risk Score = Wildlife Class weighting x Wildlife Class sub-score].
- Sum the results of all the Wildlife Class Risk Scores to obtain the Aggregate Wildlife Risk Score.
- Determine if there is a reason for an override. This occurs if one or more of the following events occurs:
  - One or more Likelihood of Strike input(s) of 4 or 5 on wildlife with a Severity of 5.
  - Two or more Likelihood of Strike inputs of 4 or 5 on wildlife with a Severity of 4.
  - Four or more Likelihood of Strike inputs of 4 or 5 on wildlife with a Severity of 3.
  - Six or more Likelihood of Strike inputs of 4 or 5 on wildlife with a Severity of 2.
  - Ten or more Likelihood of Strike inputs of 4 or 5 on wildlife with a Severity of 1.
- If an override occurs, assign an Aggregate Wildlife Risk Score commensurate with the severity of the override [0.9 for a, 0.7 for b, 0.6 for c, 0.5 for d, and 0.4 for e.] Compare the override score with the Aggregate Wildlife Risk Score calculated in step 7 and choose the larger score as the Aggregate Wildlife Risk Score.

Discussion: The non-linear scoring function and its parameters were chosen very carefully. Its output has to be on the interval [0,1] and it must have a steeper slope with low numbers of wildlife and level off as the amount of wildlife on the airport becomes large. This curve, shown below in Figure 26, models the risk associated with wildlife on the airport.

Figure 26: Graph of Wildlife Scoring Function



The assumption that more wildlife biomass on an airport increases risk forced the calculations necessary to calculate the % of Probable, since the Aggregate Wildlife Risk Score function needs to be monotonically increasing. The calculations are designed so that the results track with known data and subject matter expert opinion of the risk of certain mixes of wildlife.

10.5 Operations Data Worksheet

Overview: The Operations Data Worksheet takes the number of average monthly aircraft movements for five aircraft classes (Commercial, Air Taxi, General Aviation, Military, and Rotary) and calculates an adjustment factor to the Aggregate Wildlife Risk Score. Adjustment factors greater than 1 increase risk, less than 1 decreases risk, and an adjustment factor = 1 has no effect on the overall wildlife risk.

Input: Number of average monthly aircraft movements for Commercial, Air Taxi, General Aviation, Military, and Rotary aircraft on the airport.

Output: Operations Risk Score adjustment.

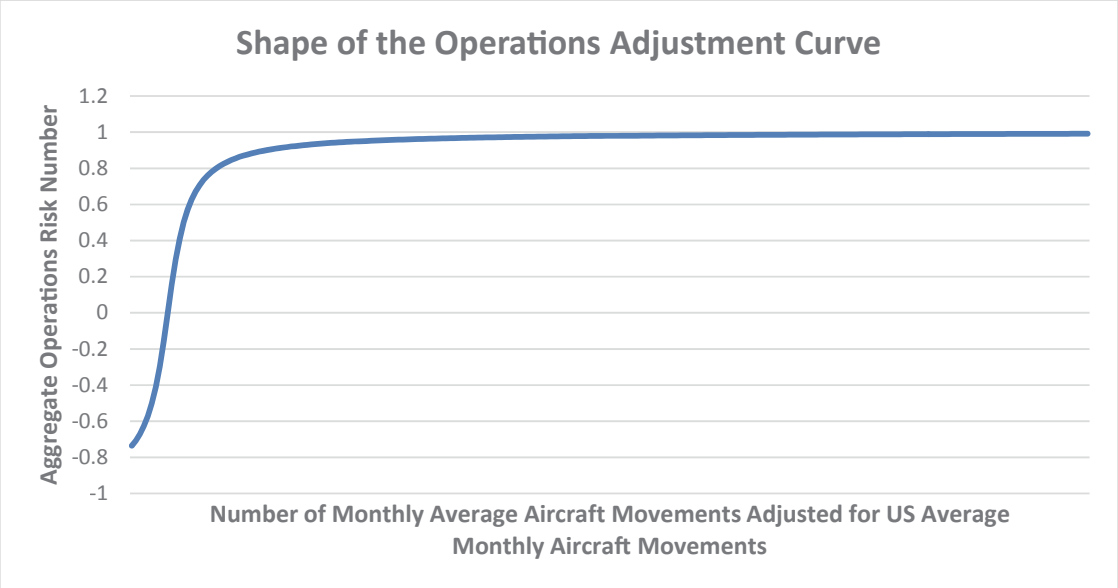
Algorithm:

- For each aircraft class, take the monthly average movements and subtract the US monthly average movements for that class. [Movement Difference = Monthly average movements – US average of monthly movements for each class].
- Use the Movement Difference to calculate the Operations Risk Number for each aircraft class. [Operations Risk Number = ATAN(Movement Difference/2000)/1.5668].
- Multiply the Operations Risk Number for each aircraft class by the weighting for each type of aircraft (0.125 for Commercial, 0.250 for Air Taxi, 0.250 for General Aviation, 0.125 for Military, and 0.250 for Rotary) to obtain the Weighted Operations Risk Number. [Weighted Operations Risk Number = Operations Risk Number x Aircraft Class Weighting].

- Sum the Weighted Operations Risk Number for each aircraft class to obtain Aggregate Operations Risk Number. [Aggregate Operations Risk Number = $\sum_k$ (Operations Risk Number Class $_k$)].
- Add the Aggregate Operations Risk Number and 1 to obtain the Operations Adjustment. [Operations Adjustment = 1 + Aggregate Operations Risk Number].

Discussion: The Operations Data Worksheet is based upon how a particular airport's monthly aircraft movements compare to the average monthly aircraft movements across the US. The average monthly aircraft movements are calculated from the FAA Air Traffic Activity Data System *(*ATADS*)* containing the official NAS air traffic operations data. If an airport has average operations, the Aggregate Operations Risk Number = 0 and there is no impact upon overall risk. If an airport has more than the average number of operations, then the Aggregate Operations Risk Number is greater than 0, and the overall airport risk score will increase as the Operations Adjustment is greater than 0. If the monthly average number of operations on an airport is less than the national average, then the Operations Aggregate Risk Number is less than 0 and the Operations Adjustment is less than 1 which means that the overall airport risk score will decrease. The aircraft class weights were derived from the FAA National Wildlife Strike Database by analyzing the number of damaging wildlife strikes for each class of aircraft. This analysis showed damaging strikes approximately in the ratios of the assigned aircraft class weights. For example, there are approximately twice as many damaging strikes as a percentage of all strikes for that aircraft class for Air Taxi, General Aviation and Rotary Wing classes than there are for Commercial and Military aircraft classes. The impact of airport operations follows a similar pattern to that of overall wildlife, the first numbers of operations increase the risk score more quickly than once there are several thousand operations at an airport. Data from airports with a high number of operations shows that there exists a certain point where the increase in risk starts to slow down as airport operations increase. This is due to consistent activity scaring wildlife away from the operations area and generally larger budgets and manpower for larger airports with associated infrastructure and equipment to mitigate wildlife hazards. Figure 27 shows the shape of the curve for airport operations risk.

Figure 27: Shape of the Operations Adjustment Curve



10.6 Habitat and Mitigation Worksheet

Overview: The Habitat and Mitigation Worksheet takes the type of habitat, its distance from airport operations, and the habitat mitigation techniques in place and calculates a Habitat Adjustment factor to the Aggregate Wildlife Risk Score. A normal, standard airport habitat was developed by subject matter experts and this standard habitat was scored using the scoring algorithm. All other airport habitats are compared to this standard habitat in the scoring.

Input: Whether or not 15 incompatible use habitats and three user-defined incompatible habitats exist on or around the airport operations, and if they exist, their distance from the airport (On Airport Property within Perimeter Fence, Outside Perimeter Fence within 10,000 foot for jet aircraft, or 5,000 foot for piston aircraft separation, Greater than the 10,000 foot or 5,000 foot separation and less than 5 miles and in traffic pattern, Greater than the 10,000 foot or 5,000 foot separation and less than 5 miles and not in traffic pattern, Greater than 5 miles but wildlife movement potential across airport). The 15 incompatible use habitats are taken from FAA Advisory Circular 150/5200-33B. If such habitat exists, then the user will input a habitat mitigation level for that habitat, 0 for none, 1 for low, 2 for moderate, and 3 for high.

Output: Habitat Risk Score Adjustment and Habitat Risk Score Adjustment – Mitigated.

Algorithm:

- Based upon the user input of habitat on and around the airport, calculate the Habitat Raw Score with mitigation for each incompatible habitat. The Habitat Raw Score is calculated by assigning points based upon the existence of the incompatible habitat at the various distances from airport operations. Table 13 shows the points assessed, higher risk equates to more points.

Table 13: Habitat Distance Points

Distance	Points
Airport Property Within Perimeter Fence	10
Outside Perimeter Fence within 10,000-foot or 5,000-foot separation	7
> 10,000 or 5,000-foot separation, within 5 miles, and in traffic pattern	4
>10,000 or 5,000-foot separation, within 5 miles, not in traffic patterns	2
> 5 miles but wildlife movement potential across airport	1

Source: The WHaMRAT (BASH Inc.)

- If the incompatible habitat has high mitigation, then subtract 3 x 1.5 points from the above score. If it has moderate mitigation, subtract 2 x 1.5 points, and if there is low mitigation subtract 1 x 1.5 points. The minimum number of points for an incompatible habitat at any given distance category from airport operations is 0. (Example: If Natural Wetlands exist on the airport within the perimeter fence and <10,000 or 5,000 foot separation, within 5 miles, and in traffic pattern, then a total of 14 points (10+4) are assessed. If the Natural Wetland has moderate mitigation on the airport but none off of the airport, 2 x 1.5 points are subtracted to give a mitigated total calculated points for Natural Wetlands of 11.0).
- Sum all of the incompatible habitat scores to obtain the Aggregate Raw Habitat Score. [Aggregate Raw Habitat Score = $\sum_k$ (Incompatible Habitat Raw Score $_k$)].
- Divide the Aggregate Raw Habitat Score by the score for the “standard” habitat score to obtain the Current Habitat Adjustment-Mitigated. Current “standard” habitat score is 100 points. [Current Habitat Adjustment-Mitigated = (Aggregate Raw Habitat Score)/(Standard Score)].

Discussion: The Habitat and Mitigation Worksheet has a linear scoring function but it seems to be one of the tougher modules to explain. Naturally, the more suitable wildlife habitat on or near the airport the higher the risk and the scoring function will reflect that principle. Mitigation techniques can eliminate a large share of the risk, but for habitat on the airport and outside the perimeter fence within 10,000 and 5,000 feet separation, the risk can never be completely eliminated unless the habitat is removed. Maximum risk points for any one single incompatible habitat are 24 if it exists in all five distance categories. With maximum mitigation the total minimum points of the habitat if it exists in all five distance categories is 8.00.

10.7 Results and Future-Projected Results Worksheets

Overview: The Results and Future-Projected Results Worksheets compile the calculated results and present a graphical depiction of Likelihood of Strike vs. Wildlife Severity and another graphical representation of Operations Adjustment vs. Wildlife Risk. There is also a number line representation of Overall Aggregate Wildlife Risk Score with an overall risk assessment of Low Risk, Moderate Risk, or High Risk and an indicator if habitat mitigation has brought the Habitat Adjustment to the minimum level for the model. The Future-Projected Results Worksheet has an additional table that compares the current ratings and scores with the future-projected ratings and scores so the user can see if the projected mitigation and operation levels have made a significant difference in the ratings and scores.

Input: The resulting calculations from Wildlife Data, Operations Data, and Habitat and Mitigation Worksheets.

Output: Ratings and scores for Aggregate Wildlife Risk, Operations Adjustment, Habitat Adjustment, Overall Aggregate Wildlife Risk Score and graphical representations of Likelihood of Strike vs. Wildlife Severity and separately Operations Adjustment vs. Wildlife Risk.

Algorithm: The algorithms to calculate the Likelihood of Strike, and Wildlife Severity for the left most graph on the results pages are below in addition to the calculation of the Operations Adjustment for the right-most graph. The calculations and the other values that are listed on the left hand side of the sheets are discussed above.

10.8 Likelihood of Strike

- Sum all of the Likelihood of Strike inputs for all species and guilds to obtain Total Likelihood. [Total Likelihood = $\sum_k$ (Likelihood of Strike for Species/Guild$_k$)].
- Calculate the Probable Maximum Likelihood total by counting the number of wildlife guilds and multiplying by the Maximum Likelihood of Strike value which is 5. [Probable Maximum Likelihood = (number of wildlife guilds represented in the model) x 5].
- Calculate the Percentage of Possible by dividing the Total Likelihood by the Probable Maximum Likelihood. [Percentage of Possible = (Total Likelihood)/(Probable Maximum Likelihood).]
- Calculate the Scaled-Matrix Plot-Likelihood by using the Percentage of Possible as input into a non-linear scaling function. [Scaled-Matrix Plot-Likelihood = (TANH(25 x (Percentage of Possible)/8.0)/0.99614) x 5.]

10.9 Wildlife Severity

- Sum all of the Wildlife Severity values for all species/guilds with a non-zero likelihood value to obtain the Total Severity Points. [Total Severity Points = $\sum_k$ (Wildlife severity rating for those species/guilds with non-zero likelihood of strike rating)].
- Calculate the Maximum Probable Severity Points given wildlife species on the airport for each wildlife class. [Probable Maximum Severity Points = Sum over all guilds in a wildlife class of (Max(Highest severity rating in a guild, Sum of the severity ratings of the wildlife present on the airport in a guild))].

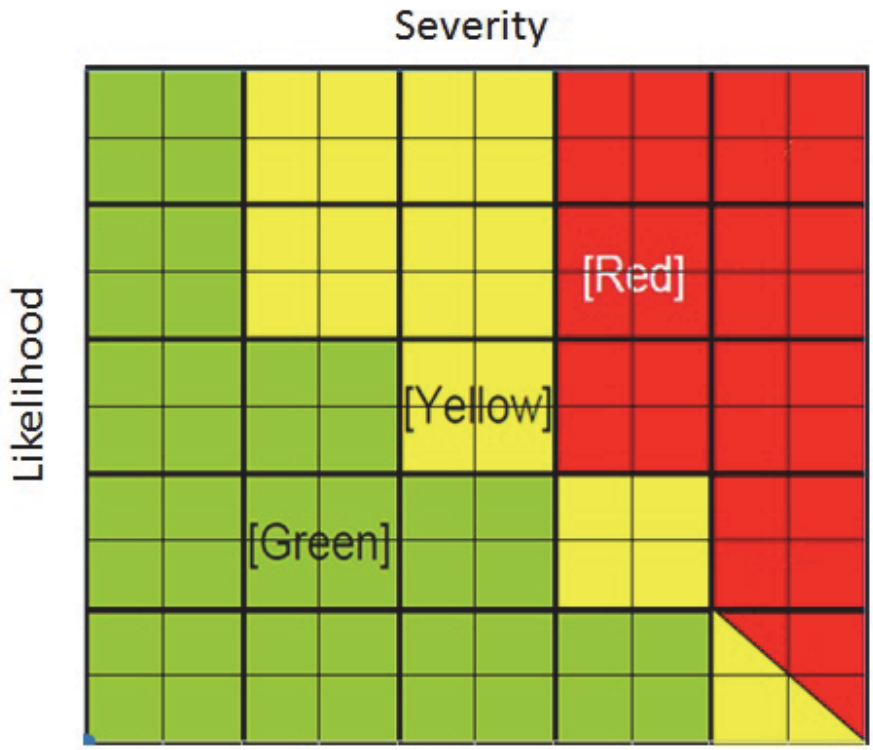
- Calculate the Percentage of Probable Severity Points by dividing the Total Severity Points by the Maximum Probable Severity Points. [Percentage of Probable Severity Points = (Total Severity Points)/(Maximum Probable Severity Points)].
- Calculate the Scaled-Matrix Plot-Severity by using the Percentage of Probable as input into a non-linear scaling function. [Scaled-Matrix Plot-Severity = (ATAN(25 x (Percentage of Probable)/15)/1.0303) x 5].

10.10 Operations Adjustment

Using the Aggregate Operations Risk number (calculation shown above in the Operations Module) obtain the Operations Risk for plotting on the risk matrix by the linear formula: Operations Adjustment = (Aggregate Operations Risk number) x 3.724794+1.3.

Discussion: The ratings of Low Risk (Green), Moderate Risk (Yellow), and High Risk (Red) are calculated using the boundaries of the FAA Risk Matrix as shown in Figure 28.

Figure 28: Risk Matrix



Source: Adapted from FAA Order 8040.4A Safety Risk Management

All three modules have modifications for the Future-Projected Results Worksheet results. The calculations are all identical; the only change is the data.

- Wildlife Data Worksheet – The impact of future mitigation is calculated by reducing the likelihood of strike by an amount equal to the increase in mitigation level. For example, if the current mitigation of a specific species is 1 with a current likelihood of strike of 4 and the future mitigation is 3 then the likelihood of strike will be reduced by 2 so the projected likelihood of strike will be 2. If the likelihood of strike was greater

than zero, then projected mitigation efforts will not reduce the likelihood of strike value to less than 1.

- Operations Data Worksheet – All calculations are the same but the airport's monthly average movements are read from the future operations table on the Operations worksheet.
- Habitat and Mitigation Worksheet – All calculations are the same except the habitat mitigation values are read from the Future Habitat Mitigation Level table on the Habitat and Mitigation Worksheet.

10.12 Differences Between The EZ-Version and Advanced-Version WHaMRAT

All of the calculations and algorithms described and explained above are exactly the same in the EZ-Version and Advanced-Version with one exception that manifests itself in two places. In the Advanced-Version, the "probable wildlife severity" score is calculated differently than in the EZ-Version. This occurs in step 3 of the algorithm in the Wildlife Data Worksheet and again in the Results Worksheet, Wildlife Severity Calculation, Step 2. In the EZ-Version, because there is only one Severity Score, instead of calculating the Max(Highest severity rating in a guild, Sum of the severity ratings of the wildlife present on the airport in a guild), the actual Severity Score listed in the EZ-Version for that guild is used in the calculation. This means that unless the Severity Score for the wildlife in a guild matches the Severity Score assigned to that guild in the EZ-Version, there will be differences between the models. If the tendency is that the wildlife on an airport have a larger biomass, and therefore, a higher Severity Score than the average Severity Scores assigned to the guilds in the EZ-Version, then the Overall Aggregate Wildlife Risk Score in the Advanced-Version will be higher than depicted in the EZ-Version. If the opposite is true and the wildlife tend toward a lower biomass than would be represented by the average Severity Score assigned to the EZ-Version guilds, then the Advanced-Version would show less risk than the EZ-Version. While further testing needs to be accomplished, the thought is that overall the differences in each guild will even out and the two models will show roughly the same level of risk for the average airport. However, it should be noted that there will be those extreme cases where the two model results will differ. In those cases, it is best to use the results of the Advanced-Version, as that model has a higher fidelity and the results will better indicate the true risk.

10.13 Conclusion

This system provides a tool to manage airport wildlife risk, taking into account airport operations, numbers and types of aircraft flown, numbers and types of wildlife encountered, behavior of wildlife, habitat on and around the airport, and mitigation efforts targeted at both habitat and wildlife. With the user input of data, it becomes specific to an individual airport, but has the potential to be used comparatively between airports. However, as currently instantiated, the WHaMRAT is intended for an airport to chart its progress, over time, in reducing risk associated with wildlife on and around the airport. This can be accomplished by running the tool on a periodic basis and comparing results for trend analysis. Finally, by inputting projected mitigation efforts and operations tempo, a user can determine the impact of planned efforts on the overall wildlife risk. The tool is powerful and as objective as possible as a measure of risk to airport and aircraft operations, but is only one of many tools an airport can use in implementing an integrated Safety Management System.

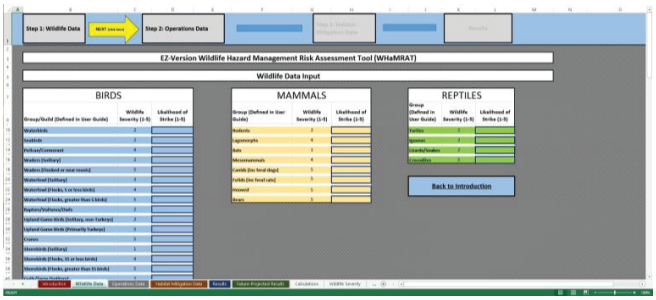
Attachment 11: EZ-Version WHaMRAT *Quick Start Guide*

Introduction

The EZ-Version Wildlife Hazard Management Risk Assessment Tool (EZ-Version WHaMRAT) is designed to assist wildlife and airport managers in assessing the wildlife risk to aircraft operations. The WHaMRAT contains three Worksheets in a spreadsheet (Excel) format that has various formulas and calculations working together to determine an Overall Aggregate Wildlife Risk Score. The tool requires user inputs that account for measures of wildlife presence and abundance, monthly average aircraft movements by aircraft class, locations of habitat considered incompatible with safe aircraft operations, and current habitat and wildlife mitigation actions. These data entries produce a numerical result and graphical representation of current wildlife risk depicted as low, moderate, or high using a 1-to-5 scale (1 is low and 5 is high). The user also has the option to enter future operations changes, as well as additional habitat and wildlife mitigation efforts and can view the potential impacts in the **Future-Projected Results Worksheet.** Below are quick start instructions to use the EZ-Version WHaMRAT. Additional step-by-step detailed instructions can be found in the User Guide.

Note: The WHaMRAT should be used in conjunction with other wildlife-related data available to the airport in making wildlife management and control decisions.

Step 1
Enter Wildlife Data



A. You will need to have an accurate estimate of wildlife presence and potential likelihood of wildlife strikes by guild derived from wildlife data reports or continual monitoring of wildlife on your airport and surrounding areas. These data should include an estimate from 1 to 5 (whole numbers only) of the wildlife presence/absence and the associated potential of a wildlife strike of representative species within each guild. Likelihood is based primarily on abundance ranging from 1 – rare, 2 – uncommon, 3 – fairly common, 4 – common, 5 – abundant. A list of guilds and species contained within each guild is available within EZ-Version Attachments in the User Guide.

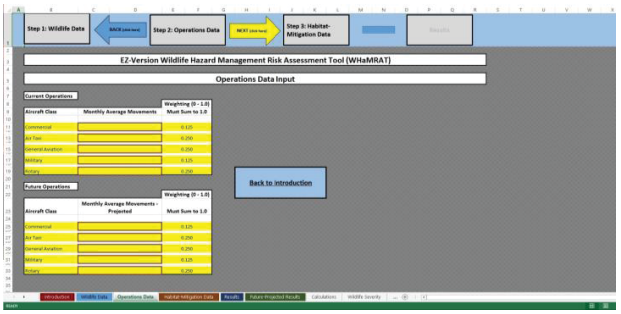
B. Once you have accounted for wildlife presence and likelihood of strike data, click the start button to proceed to the **Wildlife Data Worksheet**.

C. For each guild present on the airport, input an associated Likelihood Score for each guild ranging from 1 to 5. The WHaMRAT automatically determines a wildlife severity value based on average body mass within each guild. These values are then multiplied with the associated Likelihood Score from the user input to determine the Aggregate Wildlife Risk Score for the airport.

D. If you enter a Likelihood Score for a particular guild and that guild is highlighted red, this indicates a condition where a guild with high severity (typically a zero-tolerance guild) and a likelihood of strike associated with that guild will result in an Aggregate Wildlife Risk Score that is high and should be mitigated.

E. If you enter a Likelihood Score for a particular guild and that guild is highlighted yellow, this indicates a condition where a guild with high/moderate severity and a likelihood of strike associated with that guild might not result in an Aggregate Wildlife Risk Score that is high, but may have an adverse impact on the wildlife score and users should seriously consider additional mitigation specific to that guild.

Step 2
Enter Operations Data

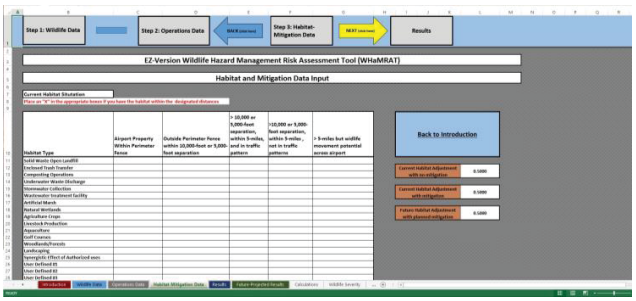


A. Once you have completed the **Wildlife Data Worksheet** input, click the arrow at the top of the page to go to the **Operations Data Worksheet.**

B. You will need to input the current average number of monthly aircraft movements for each of the 5 classes of aircraft in the Current Operations component of the Worksheet: Commercial, Air Taxi, General Aviation, Military, and Rotary Wing. These values are used to determine an adjustment factor within the WHaMRAT that is applied to the Aggregate Wildlife Risk Score.

C. If you are projecting a change in the average number of monthly aircraft movements or a change in the aircraft class and associated aircraft movements and want to determine the impact of that change on the Overall Aggregate Wildlife Risk Score, you can input the projected numbers in the Future Operations component of the Worksheet. These results will be displayed in the **Future-Projected Results** within the **Results Worksheet.**

Step 3
Enter Habitat / Mitigation Data



A. Once you have completed the Operations Data input, click the arrow at the top of the page to move to the **Habitat and Mitigation Data Worksheet**. You will input the types of wildlife habitat that are on and near (up to 5 miles) your airport. This is accomplished by inserting an "X" in the box that describes the habitat. The habitats listed are those considered incompatible with safe aircraft operations per the FAA and there are 5 possible locations.

B. For example, if you have a wastewater treatment plant within 5,000 feet for propeller-driven aircraft operations or 10,000 feet for turbofan aircraft operations, then you would place an "X" in the box that is in the Wastewater Treatment Facility row of the table and the second column (Outside Perimeter Fence within 10,000-foot or 5,000-foot separation).

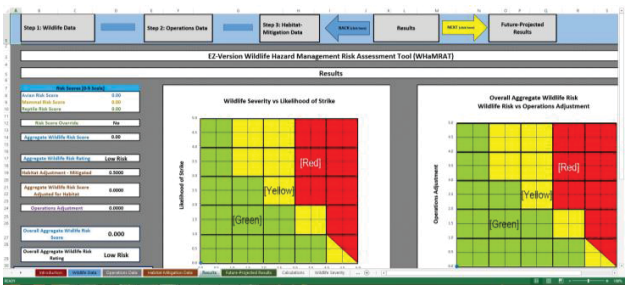
C. Following the Habitat Data entry table are three Habitat Mitigation tables. The first Habitat Mitigation table contains *current mitigation levels* for each habitat identified previously with a "1" being low mitigation, a "2" being moderate mitigation, and a "3" being high mitigation. If no mitigation is currently in place for a specific habitat and location, then leave the cells blank (no user input).

D. The second Habitat Mitigation table allows for *projected levels of mitigation*. These data inputs are optional for the user and determine the effect of planned or anticipated habitat mitigation efforts. If no changes in the level of mitigation are planned, leave the cells blank (no user input). If greater or lesser mitigation is planned, then input the increase or decrease into the specific habitat cell. The results from this table will be displayed in the **Future-Projected Results** within the **Results Worksheet.**

E. The Other Mitigation Techniques by guild is used to represent mitigation efforts targeted at specific guilds or species within a specific guild. This table contains all the guilds previously addressed in the **Wildlife Data Worksheet**. Input current mitigation efforts in the first column using the same scale as the habitat mitigation; "1" for low, "2" for moderate, and "3" for high. Similar to habitat above, if you plan to change your mitigation against a specific guild or species, input future or projected mitigation level within guilds in the second column. This information is optional and determines the impact of a specific mitigation effort on the Overall Aggregate Wildlife Risk Score. The effect of these anticipated efforts are displayed on the **Future-Projected Results** within the **Results Worksheet**.

F. Once you have completed the **Habitat and Mitigation Worksheet**, you have completed all the necessary user inputs.

Step 4
Review Results



A. Next, click the arrow at the top of the **Results Worksheet**. A list of numeric results (ranging from 1 to 5) is presented on the left side of the page.

B. The Aggregate Wildlife Risk Score is the cumulative result of guilds present (severity) and the likelihood of strike for particular guilds. Wildlife risk is based on severity multiplied by likelihood. The Overall Aggregate Wildlife Risk Score is based on Aggregate Wildlife Risk Score multiplied by Habitat Adjustment x Operations Adjustment. Adjustment factor magnitudes are determined by user inputs into the operations, habitat, and mitigation worksheets accomplished in Steps 1 through 3.

C. To the right of the numbers are two risk matrices. Both the Aggregate Wildlife Risk Score and the Overall Aggregate Wildlife Risk Score range from 1 to 5. Both scores are represented graphically as either green (low), yellow (moderate), or red (high). The second matrix represents the relationship between the Aggregate Wildlife Risk Score and the Operations Adjustment.

D. Next, click the arrow at the top of the **Future-Projected Results Worksheet** where additional scores are available to illustrate the potential for change from the current state of wildlife risk due to changes in future operations, habitat, and wildlife mitigation. The ultimate goal for all users is to continually decrease the value of the Aggregate Wildlife Risk Score and the Overall Aggregate Wildlife Risk Score. Referencing the two matrix graphs, the goal is always to move the "dot" down and to the left.

Note: Regardless of the risk score or placement of the "dot," the goal is ALWAYS to strive for continuous improvement. Within the matrix, "GREEN" is good but can always be better!

Notes

1) Each Worksheet has a link back to the **Instruction Worksheet**. To eliminate the need to click through all the worksheets to get back to the Worksheet you were working on, direct links to each Worksheet are provided in the yellow arrows.

2) When you arrive at the **Results Worksheet,** the link to the **Future-Projected Results** will appear on the top. You can also return to the **Results Worksheet** from the **Future-Projected Results Worksheet** by a link at the top of the page.

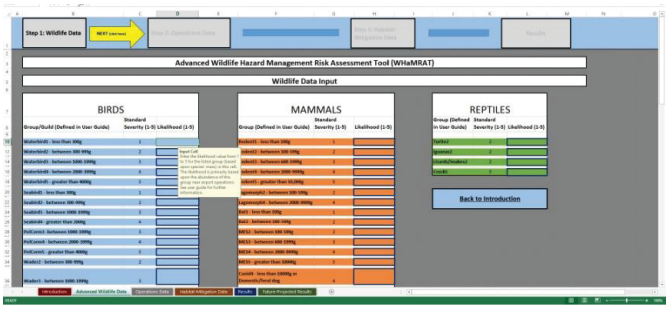
Attachment 12: Advanced-Version WHaMRAT *Quick Start Guide*

Introduction

The Advanced-Version Wildlife Hazard Management Risk Assessment Tool (Advanced-Version WHaMRAT) is designed to assist wildlife and airport managers in assessing the wildlife risk to aircraft operations. The WHaMRAT contains three worksheets in a spreadsheet (Excel) format that has various formulas and calculations working together to determine an Overall Aggregate Wildlife Risk Score. The tool requires user inputs that account for measures of wildlife presence and abundance, monthly average aircraft movements by aircraft class, locations of habitat considered incompatible with safe aircraft operations, and current habitat and wildlife mitigation actions. These data entries produce a numerical result and graphical representation of current wildlife risk depicted as low, moderate, or high using a 1-to-5 scale (1 is low and 5 is high). The user also has the option to enter future operations changes, as well as additional habitat and wildlife mitigation efforts and can view the potential impacts in the **Future-Projected Results Worksheet**. Below are quick start instructions to use the Advanced-Version WHaMRAT. Additional step-by-step detailed instructions can be found in the User Guide.

Note: The WHaMRAT should be used in conjunction with other wildlife-related data available to the airport in making wildlife management and control decisions.

Step 1
Enter Wildlife Data



A. You will need to have an accurate estimate of wildlife presence by species (grouped into body mass categories within guilds) and potential likelihood of wildlife strikes by body mass category within each guild derived from wildlife data reports, or continual monitoring of wildlife on your airport and surrounding areas. These data should include an estimate from 1 to 5 (whole numbers only) of the wildlife presence/absence and the associated potential of a wildlife strike of representative species within each body mass guild category. Likelihood is based primarily on abundance ranging from 1 – rare, 2 – uncommon, 3 – fairly common, 4 – common, 5 – abundant. A list of body mass categories within guilds and species contained within each body mass guild category is available within Advanced-Version Attachments in the User Guide.

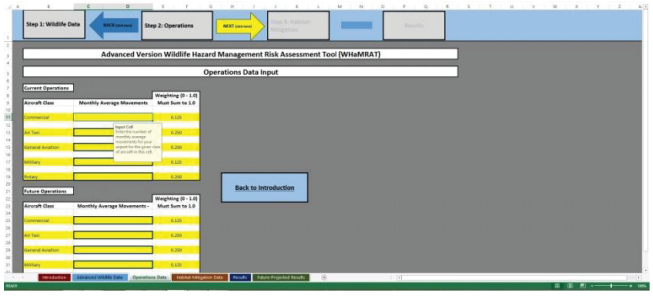
B. Once you have accounted for wildlife presence and likelihood of strike data, click the start button to proceed to the **Wildlife Data Worksheet**.

C. For each species present on the airport, input an associated Likelihood of Strike Score for each body mass guild category ranging from 1 to 5. The WHaMRAT automatically determines a wildlife severity value based on average body mass for each species within each body mass guild category. These severity values are then multiplied with the associated Likelihood Score from the user input to determine the Aggregate Wildlife Risk for the airport.

D. If you enter a Likelihood Score for a particular body mass guild category and that guild category is highlighted **red**, this indicates a condition where a guild category with high severity (typically a zero-tolerance guild) and a likelihood of strike associated with that guild will result in an Aggregate Wildlife Risk Score that is high and should be mitigated.

E. If you enter a Likelihood Score for a particular body mass guild category and that guild category is highlighted **yellow**, this indicates a condition where a guild category with high/moderate severity and a likelihood of strike associated with that guild might not result in an Aggregate Wildlife Risk Score that is high, but may have an adverse impact on the wildlife score and users should seriously consider additional mitigation specific to that guild.

Step 2
Enter Operations Data

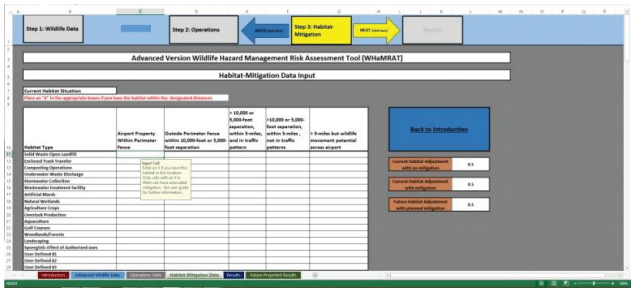


A. Once you have completed the Wildlife Data Worksheet input, click the arrow at the top of the page to go to the **Operations Data Worksheet.**

B. You will need to input the current average number of monthly aircraft movements for each of the five aircraft classes in the Current Operations component of the Worksheet: Commercial, Air Taxi, General Aviation, Military, and Rotary Wing. These values are used to determine an adjustment factor within the WHaMRAT that is applied to the Aggregate Wildlife Risk Score.

C. If you are projecting a change in the average number of monthly aircraft movements or a change in the aircraft type and associated aircraft movements and want to determine the impact of that change on the Overall Aggregate Wildlife Risk Score, you can input the projected numbers in the Future Operations component of the Worksheet. These results will be displayed in the **Future-Projected Results** within the **Results Worksheet.**

Step 3
Enter Habitat / Mitigation Data



A. Once you have completed the Operations Data input, click the arrow at the top of the page to move to the **Habitat and Mitigation Data Worksheet**. You will input the types of wildlife habitat that are on and near (up to 5 miles) your airport. This is accomplished by inserting an "X" in the box that describes the habitat presence. The habitats listed are those considered incompatible with safe aircraft operations per the FAA, combined with five possible locations.

B. For example, if you have a wastewater treatment plant within 5,000 feet for propeller-driven aircraft operations or 10,000 feet for turbofan aircraft operations, then you would place an "X" in the box that is in the Wastewater Treatment Facility row of the table and the second column (Outside Perimeter Fence within 10,000-foot or 5,000-foot separation).

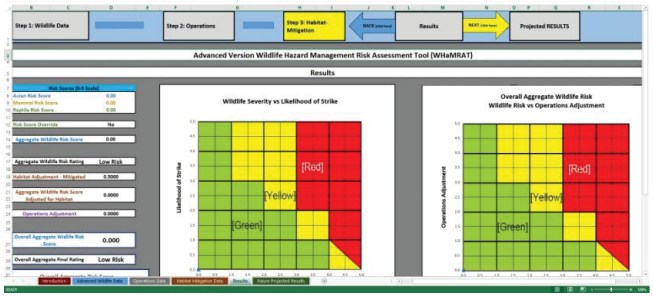
C. Following the Habitat Data entry table are three Habitat Mitigation tables. The first Habitat Mitigation table contains *current mitigation levels* for each habitat identified previously, with a "1" being low mitigation, a "2" being moderate mitigation, and a "3" being high mitigation. If no mitigation is currently in place for a specific habitat and location, then leave the cells blank (no user input).

D. The second Habitat Mitigation table allows for *projected levels of mitigation*. These data inputs are optional for the user and determine the effect of planned or anticipated habitat mitigation efforts. If no changes in the level of mitigation are planned, leave the cells blank (no user input). If greater or lesser mitigation is planned, then input the increase or decrease into the specific habitat cell. The results from this table will be displayed on the **Future-Projected Results** within the **Results Worksheet.**

E. The Other Mitigation Techniques by body mass guild category is used to represent mitigation efforts targeted at specific guilds or species within a specific guild. This table contains all the guilds previously addressed in the **Wildlife Data Worksheet**. Input current mitigation efforts in the first column using the same scale as the habitat mitigation; "1" for low, "2" for moderate, and "3" for high. Similar to habitat above, if you plan to change your mitigation against a specific body mass guild category or species, input future or projected mitigation level within guilds in the second column. This information is optional and determines the impact of a specific mitigation effort on the Overall Aggregate Wildlife Risk Score. The effect of these anticipated efforts are displayed on the **Future-Projected Results** within the **Results Worksheet**.

F. Once you have completed the **Habitat and Mitigation Worksheet**, you have completed all the necessary user inputs.

Step 4
Review Results



A. Next, click the arrow at the top of the **Results Worksheet**. A list of numeric results (ranging from 1 to 5) is presented on the left side of the page.

B. The Aggregate Wildlife Risk Score is the cumulative result of body mass guild categories present (severity) and the likelihood of strike for particular body mass guild categories. Wildlife risk is based on severity multiplied by likelihood. The Overall Aggregate Wildlife Risk Score is based on Aggregate Wildlife Risk Score multiplied by Habitat Adjustment x Operations Adjustment. Adjustment factor magnitudes are determined by user inputs into the operations, habitat, and mitigation worksheets accomplished in Steps 1 through 3.

C. To the right of the numbers are two risk matrices. Both the Aggregate Wildlife Risk Score and the Overall Aggregate Wildlife Risk Score range from 1 to 5. Both scores are represented graphically as either green (low), yellow (moderate), or red (high). The second matrix represents the relationship between the Aggregate Wildlife Risk Score and the Operations Adjustment.

D. Next, click the arrow at the top of the **Future-Projected Results Worksheet** where additional scores are available to illustrate the potential for change from the current state of wildlife risk due to changes in future operations, habitat, and wildlife mitigation. The ultimate goal for all users is to continually decrease the value of the Aggregate Wildlife Risk Score and the Overall Aggregate Wildlife Risk Score. Referencing the two matrix graphs, the goal is always to move the "dot" down and to the left.

Note: Regardless of the risk score or placement of the "dot," the goal is ALWAYS to strive for continuous improvement. Within the matrix, "GREEN" is good but can always be better!

Notes

1) Each Worksheet has a link back to the **Instruction Worksheet**. To eliminate the need to click through all the Worksheets to get back to the Worksheet you were working on, direct links to each Worksheet are provided in the yellow arrows.

2) When you arrive at the **Results Worksheet,** the link to the **Future-Projected Results** will appear on the top. You can also return to the **Results Worksheet** from the **Future-Projected Results Worksheet** by a link at the top of the page.

Abbreviations and acronyms 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
TDC	Transit Development Corporation
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

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