Wildlife Hazard Management at Airports

A Manual for Airport Personnel

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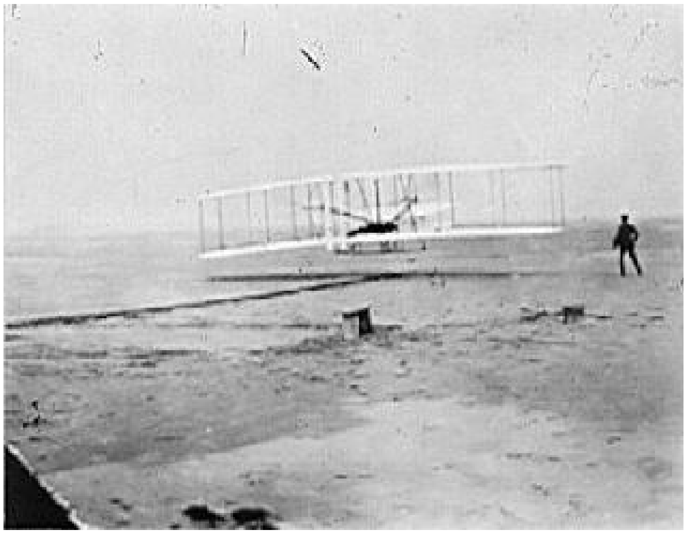
CHAPTER 1: INTRODUCTION TO THE WILDLIFE STRIKE PROBLEM

Birds and aircraft are increasingly competing for airspace in crowded skies, as demonstrated over the threshold of runway 31R at Ferihegy Airport, Budapest, Hungary, 15 June 2004 (photo © Adam Samu, used with permission).

Throughout history, humans have been intrigued and inspired by the beauty of birds and their ability to fly. Birds first took to the air about 150 million years ago. Humans first began to share their airspace only 100 years ago. Unfortunately, when aircraft and birds attempt to use the same airspace at the same time, collisions occur.

Birds are not the only wildlife problem for aircraft. Deer, coyotes, and even alligators wandering onto runways can create serious problems for departing and landing aircraft. Aircraft collisions with wildlife, also commonly referred to as wildlife strikes, annually cost the civil aviation industry in the USA at least $500 million in direct damage and associated costs and over 500,000 hours of aircraft down time. Although the economic costs of wildlife strikes are extreme, the cost in human lives lost when aircraft crash as a result of strikes best illustrates the need for management of the wildlife strike problem. This manual is designed to inform airport personnel about the scope of the wildlife strike problem and to serve as a ready reference on legal authority, regulations, and the development, implementation, and evaluation of Wildlife Hazard Management Plans for airports.



Oliver Wright recorded the first bird strike in 1905 in Ohio, less than 2 years after the Wright Brothers' first powered flight.

The first powered flight by the Wright Brothers occurred in December 1903, and the wildlife strike problem began shortly thereafter. On 7 September 1905, the first reported bird strike, as recorded by Oliver Wright in his diary, occurred when his aircraft hit a bird (probably a red-winged blackbird) as he flew over a cornfield near Dayton Ohio. The first reported mammal strike occurred on 25 July 1909 at the start of Louis Bleriot's historic first flight across the English Channel from Les Baraques, France. During engine warm-up of his Bleriot XI aircraft, a farm dog ran into the propeller. On 3 April 1912 Calbraith Rodgers, the first person to fly across the continental USA, was also the first to die as a result of a wildlife strike when his aircraft struck a gull along the coast of Southern California. Since those first wildlife strikes, aircraft designs and performance have changed radically, and wildlife populations and air traffic have increased. As a result, at least 122 civil aircraft have been destroyed and over 255 civilian lives have been lost worldwide due to wildlife strikes from 1960 to 2004. During this same period, wildlife strikes have resulted in at least 333 military aircraft destroyed and over 150 military personnel killed.

The onset of the jet age revolutionized air travel, but magnified the wildlife strike problem. Early piston-powered aircraft were noisy and relatively slow. Wildlife could usually avoid these aircraft, and strikes that did occur typically resulted in little or no damage. However, modern jet aircraft are fast and relatively quiet, and their engine fan blades are often more vulnerable than propellers to wildlife-strike damage. When turbine-powered aircraft collide with birds or other wildlife, serious structural damage and engine failure can occur. Multiple-engine damage from the ingestion of flocks of birds is of particular concern as the fleet of two-engine passenger aircraft increases in the USA. In 1969, 75% of the 2,100 passenger aircraft had 3 or 4 engines. In 1998, the fleet had grown to 5,400 primarily turbine-powered aircraft, of which only 30% had three or four engines. By 2008, the fleet will consist of about 7,000 aircraft, and less than 10% will have three or four engines.

Air travel has become commonplace in the USA. Aircraft have also assumed a vital role in tactical and logistical military operations. These factors have resulted in increased air traffic. For example, commercial air movements in the USA increased about 3% per year between 1985 and 2004. Coincidentally, human use of the skies has increased during an extremely successful period of wildlife management in North America. Aggressive natural resource and environmental protection programs by public and private wildlife management groups have contributed to impressive increases in populations of many large-bodied species such as alligators, cormorants, cranes, deer, geese, gulls, herons, pelicans, raptors (falcons, hawks, eagles, and owls), vultures, and wild turkeys. At the same time, many of these species (e.g., Canada geese, coyotes, deer, and turkeys), have expanded into suburban and urban areas, including airports, and are thriving in response to protection and changes to habitats in these areas. Almost all of these species have body masses over 4 pounds (1.8 kg), which exceed the airframe and engine certification standards for wildlife strikes. These concurrent increases in air traffic and wildlife populations contribute to an increased probability of damaging wildlife strikes. These two factors, combined with the increased speed, quietness, and vulnerability of modern aircraft, interact to form the basis of the wildlife strike problem that airport managers face. As a final factor, airport managers also face increased concerns about airport liability in the aftermath of damaging wildlife strikes (see Appendix N).

The resident Canada goose population in the USA increased at an annual rate of 8% per year between 1980 and 2004. Notice that the tall grass does not deter Canada geese from grazing and loafing at the airport (photo by M. Begier, USDA).

Wildlife strike problems at individual airports result from these above-described factors interacting at the local level. The nature and magnitude of the problem an individual airport faces will depend on many factors, including air traffic type and volume, local and migratory wildlife populations, and local wildlife habitat conditions. Wildlife is attracted to an airport environment because desirable food, water, or habitat is present. The majority of wildlife strikes occur within the immediate airport environment: 74% of all strikes occur at or below 500 feet above ground level (AGL). Eighteen of the 19 civil and military large-transport aircraft destroyed because of bird strikes between 1960 and 2004 resulted from strikes that occurred on the airport. Therefore, most wildlife involved in strikes is using the airport or its immediate vicinity, and the most logical place to begin correcting the problem is on and near the airport.

Airport sponsors and managers have a legal responsibility under federal regulations (Title 14 Code of Federal Regulations, part 139 [14 CFR, part 139]) to ensure the airport maintains a safe operating environment. As part of this responsibility, they must assess the risk and magnitude of the wildlife strike problem for their airport (14 CFR, part 139.337). This assessment must include accurate and complete reporting of all strike incidents, assessment of wildlife using the airport environment, and assessment of wildlife habitat available to wildlife on the airport. Based on airport conditions and assessed strike risk, airport personnel might need to devise a Wildlife Hazard Management Plan for reducing strike risk and occurrence. Airport personnel must then act to implement and periodically evaluate the plan.

This manual contains a compilation of information to assist airport personnel in conducting Wildlife Hazard Assessments and in the development, implementation, and evaluation of Wildlife Hazard Management Plans. This manual includes specific information on the nature of wildlife strikes, legal authority, government agency roles and responsibilities, regulations, wildlife management techniques, Wildlife Hazard Assessments, Wildlife Hazard Management Plans, and sources of help and information. It is emphasized that this manual provides only a starting point for addressing wildlife hazard issues on airports. Wildlife management is a complex, evolving, and public-sensitive discipline, and ecological conditions vary widely across the USA. Therefore, the assessment of wildlife hazards, the development of Wildlife Hazard Management Plans, and the implementation of management actions by airport personnel must be under consultation by qualified wildlife biologists trained in wildlife damage control.

While on approach to a southern USA airport in March 2003, this PA-34 aircraft struck a pair of red-breasted mergansers at 800 feet AGL. The birds penetrated both windshields. The pilot was not hurt.

CHAPTER 2:
THE FAA NATIONAL WILDLIFE STRIKE DATABASE FOR CIVIL AVIATION

Each autumn, clouds of greater snow geese arrive at Chincoteague National Wildlife Refuge, Virginia, and elsewhere along the Atlantic coast of USA from their Arctic breeding grounds in Canada and Greenland. The greater snow goose population increased from about 50,000 birds in 1966 to over 700,000 birds in 2004 (photo © Brian Kennedy/briankennedy.net, used with permission).

2.1 INTRODUCTION

Before a problem can be solved, the problem must first be understood. A necessary first step toward understanding the complex problem of aircraft collisions with wildlife is the collection and analysis of data from actual wildlife strike events. This chapter provides an overview of the structure and management of the Federal Aviation Administration (FAA) National Wildlife Strike Database for Civil Aviation. The chapter emphasizes the need for accurate reporting of wildlife strikes and the methods for reporting strike events. A statistical summary of reported wildlife strikes for civil aircraft (1990—2003) is also presented to demonstrate the types of information obtained from the database. Finally, a list of selected individual strike cases provides an overview of the nature and magnitude of the wildlife strike problem in the USA.

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2.2 REPORTING WILDLIFE STRIKES

The FAA has a standard form (Form 5200-7, Bird/Other Wildlife Strike Report [see Appendix I]) for the voluntary reporting of bird and other wildlife strikes with aircraft. To improve the ease of reporting, strikes can also be reported via the Internet (http://wildlife-mitigation.tc.faa.gov).

Pilots, airport operations, aircraft maintenance personnel, or anyone else who has knowledge of a strike should report strikes. It is important to include as much information as possible on Form 5200-7. The identification of the species of wildlife struck is particularly important. Bird strike remains that cannot be identified by airport personnel can often be identified by a local biologist or, by sending feather remains (with Form 5200-7) to—

For Material Sent via Express Mail Service:	For Material Sent via U.S. Postal Service:
Feather Laboratory Smithsonian Institution NHB, E610, MRC 116 10th & Constitution Ave. NW Washington DC 20560-0116	Feather Laboratory Smithsonian Institution, Div. of Birds PO Box 37012 NHB, E610, MRC 116 Washington DC 20013-7012
(Identify as "safety investigation material")	(Not recommended for priority cases)
The Smithsonian does not charge for feather identification services when the feathers are accompanied by an FAA Bird/Other Wildlife Strike Report (FAA Form 5200-7). Please send whole feathers if available, as diagnostic characteristics are often found in downy barbules at feather base. If available, include wings, breast, and tail feathers. Beaks, feet, bones, and talons are also useful diagnostic materials. Do not send entire bird carcasses through the mail.	

Chapter 7 and Appendix I provide more details on strike reporting.

Analyses of wildlife strike data have proven invaluable in determining the magnitude, nature, and severity of the wildlife strike problem. The database provides a scientific basis for identifying risk factors; justifying, implementing, and defending corrective actions at airports; and judging the effectiveness of those corrective actions. The database is also of critical value to engine manufacturers and aeronautical engineers.

2.3 MANAGEMENT OF THE DATABASE

The FAA National Wildlife Strike Database is managed by the Wildlife Services program of the U.S. Department of Agriculture (USDA) under terms of an Interagency Agreement with the FAA. All strike reports are sent to Wildlife Services for entry into the database after review by the staff Wildlife Biologist at the FAA, Office of Airport Safety and Standards. At the Wildlife Services office, a database manager edits each strike report and consolidates multiple reports for the same strike before entering the data.

Contacts with persons making reports are sometimes made for clarification of details. In addition to FAA Form 5200-7, strike reports are also obtained from other sources (Table 2-1). After entry into the database, the original reports are filed chronologically for future reference if necessary. There are approximately 52,500 strike records for civil aircraft in the database for 1990 through 2003.

Table 2-1. Source of information for reported wildlife strikes to civil aircraft, USA, 1990–2003.

Source	14-year total	% of total known
FAA Form 5200-7[1] (Paper)	31,497	60
FAA Form 5200-7E (Electronic)[2]	2,948	6
Airline report	7,003	13
Multiple[3]	4,704	9
Airport report	2,861	5
Other[4]	1,059	2
Engine manufacturer	793	2
Aircraft Incident Report	720	1
Preliminary Aircraft Incident Report	628	1
Aviation Safety Reporting System	152	<1
Aircraft Incident Preliminary Notice	60	<1
National Transportation Safety Board	57	<1
U.S. Air Force BASH program	11	<1
Total	52,493	100

[1] Bird/Other Wildlife Strike Report.
[2] Electronic filing of reports (http://wildlife-mitigation.tc.faa.gov) began in April 2001. In 2001, <1% of reports were filed electronically compared to 21% in 2002 and 29% in 2003.
[3] More than one report was filed for the same strike.
[4] Various sources, such as news media and Commercial Incident Reports.

In addition to the civil aviation strike reports, strike reports for military aircraft in the U.S. Air Force (USAF) database (where the strike occurred at joint use civil/military airports) have been merged into the FAA database (approximately 6,000 from 1990 to 2003). Civil and military strikes are labeled so analyses can be done with data combined or separated.

2.4 Use of and Access to Information in the Database

Maintaining a consistent record of wildlife strikes at an airport is essential for defining the wildlife hazard level and for evaluating the airport's Wildlife Hazard Management Plan, as discussed in Chapter 7. In addition to their internal use at the airport, the strike reports, when incorporated into the National Wildlife Strike Database, provide a means for engineers, biologists, and safety analysts to better understand national and regional trends in strikes and thereby develop, justify, and defend more effective management programs and wildlife-resistant aircraft and engines. For example, the database has been extremely useful in identifying which wildlife species are most commonly involved in strikes, the seasonal pattern of strikes for various species, the extent and types of damage resulting from strikes, and which aircraft types and components are most vulnerable. It is emphasized that for annual reports and other publicly released analyses, the strike records in the national database are summarized statistically at the regional or national level for trends. Comparisons among individual airports, commercial air carriers, or engine manufacturers are not made.

Selected strike records and data fields are available to the public and aviation industry online at http://wildlife-mitigation.tc.faa.gov. The general public can access information on the number of strikes by year, state, and species of wildlife. Engine manufacturers, commercial airlines, and airports, with a password supplied by the FAA, can access strike reports involving their company or airport. USDA Wildlife Services biologists and FAA Airport Certification Safety Inspectors can access strike reports for airports in the state or region, respectively, where they work.

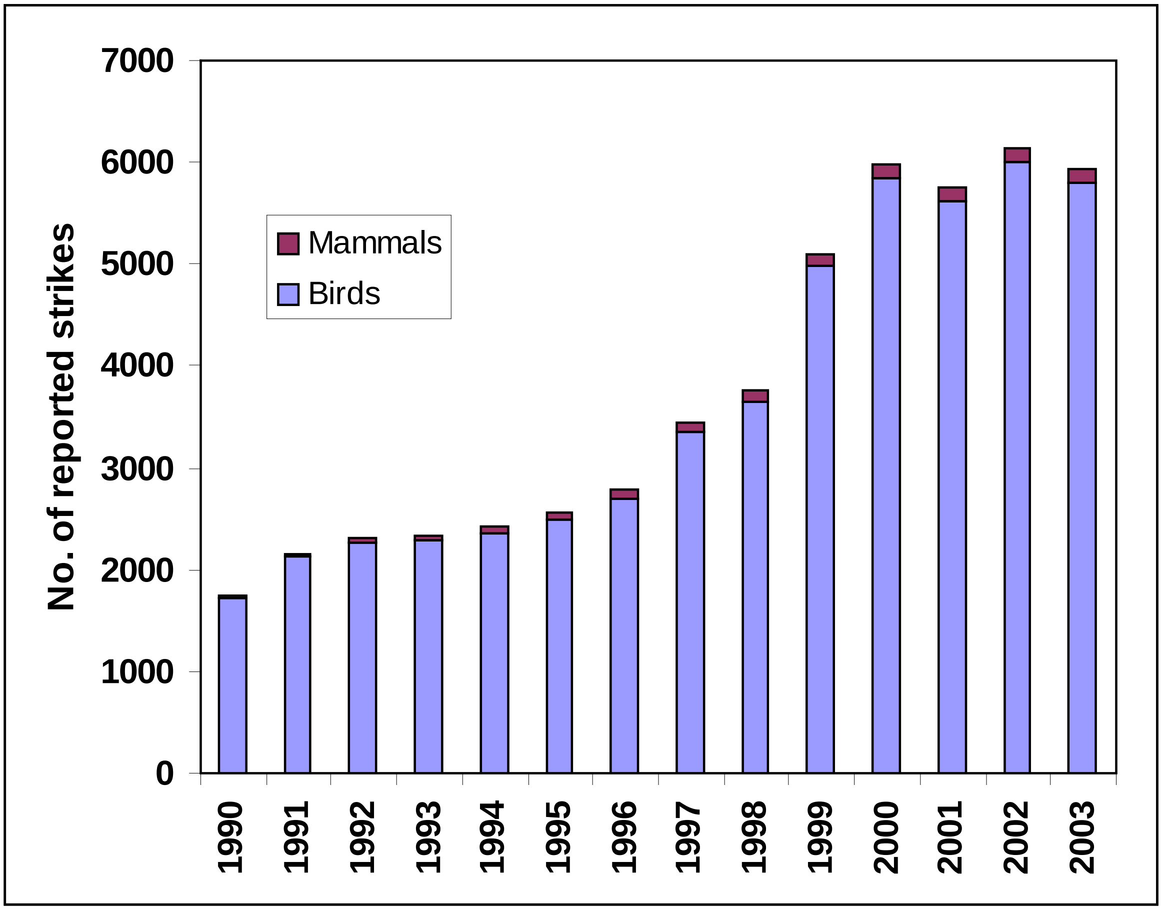


Figure 2-1. Number of reported bird (N = 51,154) and mammal (N = 1,272) strikes to civil aircraft, USA, 1990–2003. An additional 67 strikes involving reptiles were also reported for this 14-year period.

2.5 SUMMARY OF WILDLIFE STRIKE RECORDS, 1990–2003

The FAA's Office of Airport Safety and Standards, in cooperation with USDA Wildlife Services, publishes an annual report, *Wildlife Strikes to Civil Aircraft in the United States*. This report contains a detailed analysis of strike data from 1990 to the most recent year. Copies of the annual report can be downloaded from the FAA's Wildlife Hazard Mitigation Website at http://wildlife-mitigation.tc.faa.gov.

Table 2-2. Person filing report of wildlife strike to civil aircraft, USA, 1990–2003.

Person filing report	14-year total	% of total known
Airline operations	11,313	28
Pilot	10,762	27
Tower	6,672	17
Carcass found[1]	5,809	15
Airport operations	3,971	10
Other	1,520	4
Total known	40,047	100
Unknown	12,446	
Total	52,493	

[1] Airport operations personnel found wildlife remains within 200 feet of a runway centerline that appeared to have been struck by aircraft and no strike was reported by pilot, tower, or airline.

The following section presents a summary analysis of reported wildlife strikes to civil aircraft in the USA for 1990 through 2003 to provide an overview of the types of information obtained from the database. Reports were received from 1,212 airports encompassing all 50 states and some U.S. territories and from 170 foreign airports when U.S. registered aircraft were involved in a strike. Because less than 20% of all strikes have been reported to the FAA and many reports received by the FAA did not include cost or damage data or were filed before aircraft damage was fully assessed, the number of strikes and associated cost data compiled from the voluntary reporting program greatly underestimate the magnitude of the problem.

2.5.A STRIKE FREQUENCY

For the 14-year period (1990–2003), 52,493 strikes were reported to the FAA. Birds were involved in 97.4% of the reported strikes, mammals in 2.4%, and reptiles in less than 0.2% (Figure 2-1).

The number of strikes annually reported tripled from 1990 (1,739) to 2000 (5,979). From 2000 to 2003, reported strikes plateaued at about 6,000 per year with 5,940 strikes reported in 2003 (Figure 2-1). We suggest that the steady increase in reports for 1990 to 2000 was the result of several factors: an increased awareness of the wildlife strike issue, an increase in aircraft operations, an increase in populations of hazardous wildlife species, and an increase in the number of strikes. The plateau in reported strikes from 2000 to 2003 might be related to a slight (<6%) decline in air traffic after the events of September 2001 and to more aggressive wildlife hazard management programs at airports.

Table 2-3. Number of reported wildlife strikes to civil aircraft by type of operator, USA, 1990–2003.

Type of operator	14-year total	% of total known
Commercial	38,005	84
Business	5,596	12
Private	1,567	4
Government/Police	266	<1
Total known	45,434	100
Unknown	7,059	
Total	52,493	

Most (66%) of the 52,493 strike reports filed during the 14-year period were submitted using the paper (60%) or electronic (6%) version of FAA Form 5200-7, *Bird/Other Wildlife Strike Report*. Since the online version of this form became available in April 2001, use of the electronic reporting system has climbed dramatically. Almost 28% of the strike reports filed in 2003 were done using this system (Table 2-1).

Table 2-4. Number of reported bird, mammal, and reptile strikes to civil aircraft by USA state, including the District of Columbia (DC), Puerto Rico (PR), USA-possessed Pacific Islands (PI), and the U.S. Virgin Islands (VI), 1990–2003.

	Reported strikes					Reported strikes			
State	Birds	Mammals	Reptiles	Total	State	Birds	Mammals	Reptiles	Total
AK	393	14	0	407	NC	997	20	0	1,017
AL	489	12	0	501	ND	121	3	0	124
AR	222	13	0	235	NE	461	13	0	474
AZ	712	51	0	763	NH	297	10	0	307
CA	4,325	54	0	4,379	NJ	1,427	67	7	1,501
CO	1,290	59	0	1,349	NM	94	2	0	96
CT	561	16	0	577	NV	248	3	0	251
DC	1,307	30	0	1,337	NY	2,903	96	10	3,009
DE	36	1	0	37	OH	1,626	53	0	1,679
FL	3,622	49	40	3,711	OK	470	19	2	491
GA	866	15	0	881	OR	810	8	0	818
HI	1,047	4	0	1,051	PA	1,962	63	0	2,025
IA	335	12	0	347	PI	80	0	0	80
ID	102	5	0	107	PR	85	0	5	90
IL	2,521	71	1	2,593	RI	209	7	0	216
IN	527	11	0	538	SC	248	12	0	260
KS	148	5	0	153	SD	82	6	0	88
KY	1,203	12	0	1,215	TN	1,328	15	0	1,343
LA	949	18	1	968	TX	3,416	60	0	3,476
MA	684	12	0	696	UT	535	10	0	545
MD	556	40	0	596	VA	735	42	0	777
ME	157	8	0	165	VI	67	0	0	67
MI	1,248	70	0	1,318	VT	41	1	0	42
MN	435	13	0	448	WA	785	11	0	796
MO	1,040	26	0	1,066	WI	437	43	0	480
MS	171	4	0	175	WV	123	45	0	168
MT	61	5	0	66	WY	39	4	0	43
					Total known[1]	44,633	1,243	66	45,942
					Foreign[2]	983	8	0	991
					Unknown	5,538	21	1	5,560
					Total	51,154	1,272	67	52,493

[1] Strikes were reported at 1,212 airports in the USA.
[2] Strikes to USA air carriers were reported at 170 foreign airports.

Table 2-5. Number of reported strikes, strikes with damage, and strikes having a negative effect-on-flight (EOF) for the five most commonly struck bird species groups and two most commonly struck mammal groups, USA, 1990–2003.

Species group	Reported strikes: 14-year total	Reported strikes: % of total known	Strikes with damage: 14-year total	Strikes with damage: % of total known	Strikes with EOF: 14-year total	Strikes with EOF: % of total known
Birds						
Gulls	5,323	25	891	28	710	30
Doves/pigeons	2,966	14	245	8	264	11
Raptors	2,666	12	537	17	351	15
Waterfowl	2,217	10	1,023	32	477	20
Blackbirds/starlings	2,210	10	131	4	156	7
All other known	6,302	29	390	12	406	17
Total known	21,684	100	3,217	100	2,364	100
Unknown	29,470		3,483		1,952	
Total birds	51,154		6,700		4,316	
Mammals						
Artiodactyls[1]	643	51	524	94	339	85
Carnivores[2]	312	25	23	4	48	12
All other known	305	24	11	2	10	3
Total known	1,260	100	558	100	397	100
Unknown	12		6		6	
Total mammals	1,272		564		403	

[1] Deer and elk, respectively, comprised 614 and 8 of the 643 strikes with artiodactyls.
[2] Coyotes and foxes, respectively, comprised 150 and 59 of the 312 strikes with carnivores.

Pilots and airline personnel filed 28% and 27% of these 52,493 reports, respectively (Table 2-2). About 84% of the reported strikes involved commercial aircraft; the remainder involved business, private, and miscellaneous aircraft (Table 2-3). California, Florida, and Texas had the most (3,416–4,325) bird strike reports (Table 2-4). Twelve other states each had over 1,000 bird strikes reported. New York, Illinois, Michigan, New Jersey, Pennsylvania, and Texas each had 60 or more mammal strikes.

Table 2-6. Number of reported bird and mammal strikes to civil aircraft by month, USA, 1990–2003[1].

	All birds		All mammals		Deer only[2]	
Month	14-year total	% of total known	14-year total	% of total known	14-year total	% of total known
Jan	1,969	4	60	5	27	4
Feb	1,806	4	50	4	21	3
Mar	2,712	5	73	6	31	5
Apr	3,537	7	83	7	40	7
May	4,729	9	65	5	27	4
Jun	3,806	7	102	8	45	7
Jul	5,678	11	127	10	50	8
Aug	6,845	13	154	12	50	8
Sep	6,919	14	150	12	64	10
Oct	6,685	13	171	13	85	14
Nov	4,100	8	168	13	126	21
Dec	2,368	5	69	5	48	8
Total	51,154	100	1,272	100	614	100

[1] In addition, 67 strikes with reptiles were reported, of which 16 (24%) occurred in September.

[2] Deer strikes were comprised of 574 white-tailed deer, 24 mule deer, and 16 deer not identified to species. Other wild ungulates reported struck (but not included in this column of table) were 8 elk, 7 pronghorns, 7 moose, and 1 caribou.

Table 2-7. Reported time of occurrence of wildlife strikes to civil aircraft, USA, 1990–2003.

	Birds		Mammals	
Time of day	14-year total	% of total known	14-year total	% of total known
Dawn	1,567	4	23	3
Day	22,632	63	200	24
Dusk	1,922	5	81	10
Night	9,562	27	536	64
Total known	35,683	100	840	100
Unknown	15,471		432	
Total[1]	51,154		1,272	

[1] In addition, 67 strikes with reptiles were reported: 56 for which the time was not reported, 6 during the day, 3 at night, 1 at dawn, and 1 at dusk.

2.5.B TYPES OF WILDLIFE INVOLVED

Gulls (25%), doves (14%), raptors (12%), and waterfowl (10%) were the most frequently struck bird groups (Table 2-5). Gulls were involved in more than twice as many strikes as waterfowl (5,323 and 2,217, respectively). Waterfowl, however, were involved in more damaging strikes (1,023 or 32% of all damaging strikes in which the bird type was identified) than were gulls (891 or 28% of all damaging strikes in which the bird type was identified). Gulls were responsible for the greatest number of bird strikes (710 or 30%) that had a negative effect-on-flight.

The most frequently struck mammals were Artiodactyls—primarily deer (51%)—and Carnivores—primarily coyotes (25%, Table 2-5). Artiodactyls were responsible for 94% of the mammal strikes that resulted in damage and 85% of the mammal strikes that had a negative effect-on-flight. In all, 38 identified species of mammals were reported struck; 17 identified species caused damage.

2.5.C CHARACTERISTICS OF STRIKES

Most bird strikes (51%) occurred between July and October (Table 2-6); 63% occurred during the day (Table 2-7); 58% occurred during the landing (descent, approach, or landing roll) phase of flight; and 39% occurred during takeoff and climb (Table 2-8). About 61% of the bird strikes occurred when the aircraft was at a height of 100 feet or less above ground level (AGL), 74% occurred at 500 feet or less AGL, and 92% occurred at or below 3,000 feet AGL (Table 2-9).

Table 2-8. Reported phase of flight at time of wildlife strikes to civil aircraft, USA, 1990–2003.

	Birds		Mammals	
Phase of flight	14-year total	% of total known	14-year total	% of total known
Parked	24	<1	0	0
Taxi	161	<1	24	3
Takeoff run	7,810	20	318	33
Climb	7,327	19	26	2
En route	1,148	3	1	<1
Descent	1,463	4	4	<1
Approach	15,065	38	82	8
Landing roll	6,461	16	498	52
Total known	39,459	100	953	100
Unknown	11,695		319	
Total[1]	51,154		1,272	

[1] In addition, 67 strikes with reptiles were reported.

Most mammal strikes (50%) occurred between August and November with 35% of deer strikes concentrated in October and November (Table 2-6). Most mammal strikes (64%) occurred at night (Table 2-7), 52% occurred during the landing roll, and 33% occurred during the takeoff run. About 10% of the reported mammal strikes occurred while the aircraft was in the air, e.g., when the aircraft struck deer with the landing gear or encountered bats (Table 2-8).

2.5.D AIRCRAFT COMPONENTS STRUCK AND DAMAGED

The aircraft components most commonly reported as struck by birds were the nose/radome, windshield, engine, wing/rotor, and fuselage (Table 2-10). Aircraft engines were the component most frequently reported as being damaged by bird strikes (33% of all damaged components). Of the 7,511 aircraft engines reported as being struck by birds, 34% (2,591) were damaged (Table 2-10).

There were 6,761, 350, 10, and 5 incidents in which one, two, three, and four engines, respectively, were struck by birds on a single aircraft. There were 2,424, 80, 1, and 1 incidents in which one, two, three, and four engines, respectively, were damaged by birds on a single aircraft.

Table 2-9. Number of reported bird strikes to civil aircraft by height (feet) above ground level (AGL), USA, 1990–2003.

Height of strike (feet AGL)	14-year total	% of total known	% cumulative total
0	14,471	41	41
1-100	6,716	19	61
101-200	1,704	5	65
201-300	1,126	3	69
301-400	682	2	71
401-500	1,204	3	74
501-600	333	1	75
601-700	262	1	76
701-800	561	2	77
801-900	186	1	78
901-1,000	1,002	3	81
1,001-2,000	2,570	7	88
2,001-3,000	1,517	4	92
3,001-4,000	776	2	95
4,001-5,000	575	2	96
5,001-10,000	1,062	3	99
10,001-20,000	237	<1	99
20,001-30,000	11	<1	99
>30,000	1	<1	100
Total known	34,996	100	
Unknown	16,158		
Total	51,154		

Aircraft components most commonly reported as struck by mammals were the landing gear, propeller, and wing/rotor. These same components ranked highest for the parts most often reported as damaged by mammals (Table 2-10).

2.5.E Effects of Wildlife Strikes on Aircraft and Flights

For the 14-year period, 7,265 reports (17% of known total) indicated the strike damaged one or more aircraft components (Table 2-9), and 4,726 reports (15% of known total) indicated the strike had a negative effect on the flight (Table 2-11). Only 2,630 strike reports provided an estimate of the aircraft down time (total = 455,931 hours, average = 173 hours/incident), and 1,759 reports provided an estimate of the direct or other costs (total = $195,034,000, average = $147,000/incident). Of the 1,759 reports providing a damage cost estimate, 1,637 provided an estimate of direct aircraft damage (total = $169,045,000, average = $103,000/incident), and 595 provided an estimate of other monetary losses (total = $25,989,000, average = $44,000/incident).

Assuming all reported wildlife-aircraft strikes that had an adverse effect on the aircraft and/or flight engendered similar amounts of down time and/or monetary losses and that these reports are all of the damaging strikes that occurred, wildlife strikes cost the U.S. civil aviation industry a minimum of 118,663 hours per year of aircraft down time and

$100.58 million in monetary losses ($70.68 million per year in direct costs and $29.90 million per year in associated costs). Further, assuming a 20% reporting rate, the annual cost of wildlife-aircraft strikes to the U.S. civil aviation industry is estimated to be in excess of 593,317 hours of aircraft downtime and $502.91 million in monetary losses ($353.42 million per year in direct costs and $149.49 million per year in associated costs).

Table 2-10. Civil aircraft components reported as being struck and damaged by wildlife, USA, 1990–2003.

	Birds (14-year total)				Mammals (14-year total)			
Aircraft component	Number struck	% of total	Number damaged	% of total	Number struck	% of total	Number damaged	% of total
Radome/nose	12,044	26	1,201	15	69	6	65	6
Windshield	8,145	18	482	6	16	1	11	1
Engine(s)	7,511[1]	16	2,591[1]	33	98	8	95	9
Wing/rotor	6,243	14	1,751	22	144	12	141	14
Fuselage	5,726	12	275	3	82	7	91	9
Landing gear	2,252	5	249	3	452	37	239	24
Propeller	1,415	3	153	2	169	14	157	15
Tail	693	2	305	4	37	3	45	4
Light	386	1	305	4	15	1	22	2
Other	1,675	4	631	8	146	12	148	14
Total[2]	46,090	100	7,943	100	1,228	100	1,014	100

[1] There were 7,126 bird-strike incidents in which a total of 7,511 engines were reported as struck (6,761 incidents with one engine struck, 350 with two engines struck, 10 with three engines struck, and five with four engines struck). In 2,506 (35%) of these 7,126 strike incidents, a total of 2,591 engines were damaged (2,424 incidents with one engine damaged, 80 with two engines damaged, one with three engines damaged, and one with four engines damaged).

[2] In addition, 67 strikes with reptiles were reported; 15 indicated the part struck and 5 indicated the strike damaged an aircraft component: Windshield (1 struck, 1 damaged), Wing/rotor (1 struck, 1 damaged), Fuselage (1 struck, 1 damaged), Landing gear (10 struck, 0 damaged), Tail (1 struck, 1 damaged), Other (1 struck, 1 damaged).

Table 2-11. Number of civil aircraft with reported damage resulting from wildlife strikes, USA, 1990–2003.

	Reported strikes					
	Birds		Mammals		Total[1]	
Damage category [2]	14-year total	% of total known	14-year total	% of total known	14-year total	% of total known
None	36,122	84	348	38	36,481	83
Damage	6,700	16	564	62	7,265	17
Minor	3,659	9	262	29	3,921	9
Uncertain	1,184	3	39	4	1,223	3
Substantial	1,845	4	247	27	2,093	5
Destroyed	12	<1	16	2	28	<1
Total known	42,822	100	912	100	43,746	100
Unknown	8,332		360		8,747	
Total	51,154		1,272		52,493	

[1] Included in totals are 67 strikes involving reptiles in which 11 reports indicated no damage, 55 failed to report damage (if any), and 1 reported substantial damage.

[2] The damage codes and descriptions follow the *International Civil Aviation Organization Bird Strike Information System (1989):* Minor = the aircraft can be rendered airworthy by simple repairs or replacements and an extensive inspection is not necessary; Uncertain = the aircraft was damaged, but details as to the extent of the damage are lacking; Substantial = the aircraft incurs damage or structural failure that adversely affects the structure strength, performance, or flight characteristics of the aircraft and that would normally require major repair or replacement of the affected component (specifically excluded are bent fairings or cowlings; small dents or puncture holes in the skin; damage to wing tips, antenna, tires, or brakes; and engine blade damage not requiring blade replacement); Destroyed = the damage sustained makes it inadvisable to restore the aircraft to an airworthy condition.

Table 2-12. Reported effect-on-flight (EOF) of wildlife strikes to civil aircraft, USA, 1990–2003.

	Reported strikes					
	Birds		Mammals		Total[1]	
Effect-on-flight[2]	14-year total	% of total known	14-year total	% of total known	14-year total	% of total known
None	26,493	86	315	44	26,821	85
Negative effect	4,316	14	403	56	4,726	15
Precautionary landing	2,235	7	63	9	2,299	7
Aborted takeoff	1,072	4	130	18	1,202	4
Engine shutdown	251	1	22	3	273	1
Other	758	3	188	26	952	3
Total known	30,809	100	718	100	31,547	100
Unknown	20,345		554		20,946	
Total	51,154		1,272		52,493	

[1] Included in totals are 67 strikes involving reptiles in which 13 reports indicated no effect-on-flight, 47 failed to report on effect-on-flight (if any), 1 reported a precautionary landing, and 6 reported “other”.

[2] Effect-on-flight: None = flight continued as scheduled, although delays and other cost caused by inspections or repairs may have been incurred after landing; Aborted takeoff = pilot aborted the takeoff; Precautionary landing = pilot landed at other-than-destination airport after strike; Engine shut down = pilot shut down the engine or the engine stopped running because of strike; Other = miscellaneous effects, such as reduced speed because of shattered windshield, emergency landing at destination airport, or crash landing; Unknown = report did not give sufficient information to determine an effect-on-flight (Dolbeer et al. 2000).

2.6 SELECTED EXAMPLES OF WILDLIFE STRIKES

Below are descriptions of some wildlife strikes that are either of historic interest, have influenced flight safety, or are typical of damaging strikes in recent years in the USA.

7 September 1905. From the Wright Brothers diaries, "Orville … flew 4,751 meters in 4 minutes 45 seconds, four complete circles. Twice passed over fence into Beard's cornfield. Chased flock of birds for two rounds and killed one which fell on top of the upper surface and after a time fell off when swinging a sharp curve." This was the first reported bird-aircraft strike. Because of the location near Dayton, Ohio, and time of year, the bird struck was probably a red-winged blackbird.

Calbraith Rogers and his aircraft the Vin Fizz following his fatal encounter with a gull (photo courtesy National Air and Space Museum, Smithsonian Institution, SI Neg. No. A-43520-E).

25 July 1909. During engine warm-up for Louis Bleriot's historic first flight across the English Channel from Les Baraques, France, a farm dog ran into the propeller of the Bleriot XI aircraft. This was the first reported terrestrial wildlife (mammal) strike.

3 April 1912. Calbraith Rogers, the first person to fly across the continental USA, was also the first to die as a result of a wildlife strike. On 3 April 1912, Rodgers' Wright Pusher struck a gull, causing the aircraft to crash into the surf at Long Beach, California. Rodgers was pinned under the wreckage and drowned.

4 October 1960. A Lockheed Electra turbo-prop ingested European starlings into all four engines during takeoff from Boston Logan Airport (Massachusetts). The plane crashed into Boston Harbor, killing 62 people. Following this accident, the FAA initiated action to develop minimum bird ingestion standards for turbine-powered engines.

26 February 1973. On departure from Atlanta's Peachtree-Dekalb Airport (Georgia), a Lear 24 jet struck a flock of brown-headed cowbirds attracted to a nearby trash disposal area. Engine failure resulted. The aircraft crashed, killing seven people and seriously injuring one person on the ground. This incident prompted the FAA to develop guidelines for the location of solid waste disposal facilities on or near airports.

12 November 1975. On departure roll from John F. Kennedy International Airport (New York), the pilot of a DC-10 aborted takeoff after ingesting gulls into one engine. The plane ran off runway and caught fire as a result of engine fire and overheated brakes. The resultant fire destroyed the aircraft. All 138 people on board, airline personnel trained in emergency evacuation, evacuated safely (see photo page 18). Following this accident, the National Transportation Safety Board recommended the FAA evaluate the effect of bird ingestion on large, high-bypass, turbofan engines and the adequacy of engine certification standards. The FAA initiated a nationwide data collection effort to document bird strike and engine ingestion events.

This DC-10 was destroyed by fire when several herring gulls were ingested into an engine during takeoff from JFK International Airport, November 1975 (see story on page 17; photo courtesy Port Authority New York and New Jersey).

25 July 1978. A Convair 580 departing Kalamazoo Airport (Michigan) ingested one American kestrel into an engine on takeoff. The aircraft auto-feathered and crashed in a nearby field, injuring 3 of the 43 passengers.

18 June 1983. The pilot of a Bellanca 1730, landing at Clifford, Texas, saw two "buzzards" on final approach. He added power and maneuvered to avoid them, then continued approach. This resulted in a landing beyond the intended point. The middle of the runway was higher than either end; therefore, the pilot was unable to see a large canine moving toward the landing area until aircraft was halfway down the runway. A go-around was initiated, but the lowered landing gear hit some treetops causing the pilot to loose control. The aircraft came to rest in a milo field about 250 yards from initial tree impact after flying through additional trees. The aircraft suffered substantial damage, and two people in the aircraft were seriously injured.

6 January 1985. A Beechcraft King Air 90 departing Smith Reynolds Airport (North Carolina) at dusk hit a large feral dog on the runway just at rotation. The aircraft suffered substantial damage.

17 March 1987. A Boeing-737 struck an 80-pound deer at Chicago O'Hare (Illinois) airport. The aircraft suffered over $114,000 in damage.

5 November 1990. During takeoff at Michiana Regional Airport (Indiana), a BA-31 flew through a flock of mourning doves. Several birds were ingested in both engines, and takeoff was aborted. Both engines were destroyed. Cost of repairs was $1 million, and time out of service was 60 hours.

30 December 1991. A Citation 550, taking off from Angelina County Airport (Texas), struck a turkey vulture. The strike caused major damage to the #1 engine and resulting shrapnel caused minor damage to the wing and fuselage. Cost of repairs was $550,000 and time out of service was 2 weeks.

2 February 1992. A Piper Cherokee struck a deer at rotation during takeoff from Sandstone Municipal Airport (MN). The pilot attempted to turn back to the airport but collided into trees just south of airport. The aircraft was destroyed and the pilot seriously injured.

3 December 1993. A Cessna 550 struck a flock of geese during the initial climb out of DuPage County Airport (Illinois). The pilot heard a loud bang, and the aircraft yawed to the left and right. Instruments showed loss of power to the #2 engine and a substantial fuel leak on the left side. An emergency was declared, and the aircraft landed at

Midway Airport. The cost to repair two engines was $800,000, and time out of service was about 3 months.

21 October 1994. A Cessna 210 struck a coyote during the landing roll at Higginsville Industrial Municipal Airport (Missouri) at night. The nose gear collapsed and the propeller hit the runway, resulting in major damage to the engine and crankshaft.

3 June 1995. An Air France Concorde, at about 10 feet AGL while landing at John F. Kennedy International Airport (New York), ingested one or two Canada geese into the #3 engine. The engine suffered an uncontained failure. Shrapnel from the #3 engine destroyed the #4 engine and cut several hydraulic lines and control cables. The pilot was able to land the plane safely, but the runway was closed for several hours. Damage to the Concorde was estimated at over $7 million. The French Aviation Authority sued the Port Authority of New York and New Jersey and eventually settled out of court for $5.3 million.

A USAF AWACS aircraft similar to this was lost in 1995 and 24 airmen were killed when Canada geese were struck just after rotation. The USAF was aware of geese living on the airbase, yet had taken no direct action to eliminate the birds (photo courtesy USAF).

22 September 1995. A U.S. Air Force Airborne Warning and Control System (AWACS) aircraft (modified Boeing 707) crashed, killing all 24 on board, after ingesting four Canada geese into the #1 and #2 engines during takeoff from Elmendorf Air Force Base (Alaska). This was the first crash of an AWACS plane since the Air Force began using them in 1977.

5 October 1996. A Boeing-727 departing Washington Reagan National Airport (District of Columbia) struck a flock of gulls just after takeoff, ingesting at least one bird. One engine began to vibrate and was shut down. A burning smell entered the cockpit. An emergency was declared, and the aircraft, carrying 52 passengers, landed at Washington Reagan National. Several engine blades were damaged.

7 January 1997. An MD-80 aircraft struck over 400 blackbirds just after takeoff from Dallas-Fort Worth International Airport (Texas). Almost every part of the plane was hit. The pilot declared an emergency and returned to land without event. Substantial damage was found on various parts of the aircraft, and the #1 engine had to be replaced. The runway was closed for 1 hour. The birds had been attracted to an un-harvested wheat field on the airport.

9 January 1998. While climbing through 3,000 feet, following takeoff from Houston Intercontinental Airport (Texas), a Boeing-727 struck a flock of snow geese with three to five birds ingested into one engine. The engine lost all power and was destroyed. The radome was torn from aircraft and leading edges of both wings were damaged. The pitot tube for the first officer was torn off. Intense vibration was experienced in the airframe and the noise level in the cockpit increased to the point that communication among crewmembers became difficult. An emergency was declared. The flight returned safely to Houston with major damage to aircraft.

22 February 1999. A Boeing-757 departing Cincinnati/Northern Kentucky International Airport (Kentucky) had to return and make an emergency landing after hitting a large flock of starlings. Both engines and one wing received extensive damage. About 400 dead starlings were found on the runway area.

7 February 2000. An American-owned cargo company's DC-10-30 departing Subic Bay, Philippines, ingested a fruit bat into one engine at 250 feet AGL. The aircraft returned to the airport. Five damaged fan blades had to be replaced. Time out of service was 3 days. Total repair and related costs exceeded $3 million.

21 January 2001. An MD-11 departing Portland International Airport (Oregon) ingested a herring gull into the #3 engine during the takeoff run. The engine stall blew off the nose cowl that was sucked back into the engine and shredded. The engine had an uncontained failure. The pilot aborted takeoff and blew two tires. The 217 passengers were safely deplaned and rerouted to other flights. Smithsonian Feather Lab identified bird.

One of the two turkeys that penetrated a Canadair RJ 200 fuselage below the windshield; parts of the bird entered the cockpit.

09 March 2002. A Canadair RJ 200 at Dulles International Airport (Virginia) struck two wild turkeys during the takeoff roll. One shattered the windshield spraying the cockpit with glass fragments and remains. Another hit the fuselage and was ingested. There was a 14-by 4-inch section of fuselage skin damaged below the windshield seal on the flight officer's side. The cost of repairs was estimated at $200,000. Time out of service was at least 2 weeks.

19 October 2002. A Boeing 767 departing Logan International Airport (Massachusetts) encountered a flock of over 20 double-crested cormorants. At least 1 cormorant was ingested into the #2 engine. There were immediate indications of engine surging followed by compression stall and smoke from the engine. The engine was shutdown. An overweight landing with one engine was made without incident. The nose cowl was dented and punctured. There was significant fan blade damage with abnormal engine vibration. One fan blade was found on the runway. The aircraft was towed to the ramp. Hydraulic lines were leaking, and several bolts were sheared off inside engine. Many pieces fell out when the cowling was opened. The aircraft was out of service for 3 days. The cost of repairs was $1.7 million.

8 January 2003. A Bombardier de Havilland Dash 8 collided with a flock of lesser scaup at 1,300 feet AGL on approach to Rogue Valley International Airport (Oregon). At least one bird penetrated the cabin and hit the pilot who turned control over to the first officer for landing. Emergency power switched on when the birds penetrated the radome and damaged the DC power system and instruments systems. The pilot was treated for cuts and released from the hospital.

This picture shows a close-up of the #2 engine from the Fokker-100 that ingested Canada geese on 4 September 2004.

4 September 2003. A Fokker 100 struck a flock of at least five Canada geese over the runway shortly after takeoff at LaGuardia Airport (New York), ingesting one or two geese into the #2 engine. Engine vibration occurred. The pilot was unable to shut the engine down with the fuel cutoff lever, so the fire handle was pulled and the engine finally shut down, but the vibration continued. The flight was diverted to nearby JFK International Airport where a landing was made. The NTSB found a 20- by 36-inch wide depression on the right side of nose behind radome. Maximum depth was 4 inches. Impact marks were found on the right wing. A fan blade separated from the disk and penetrated the fuselage. Several fan blades were deformed. Holes were found in the engine cowling. Bird remains were recovered and identified by Wildlife Services.

17 February 2004. A Boeing 757 during a takeoff run from Portland International Airport (Oregon) hit five mallards and returned with one engine out. At least one bird was ingested, and parts of five birds were collected from the runway. Engine damage was not repairable, and the engine had to be replaced. The cost was $2.5 million, and time out of service was 3 days.

This is the #1 engine of the MD-80 after ingesting at least 1 double-crested cormorant on 16 September 2004. (See story on page 22.)

15 April 2004. An Airbus 319 climbing out of Portland International Airport (Oregon) ingested a great blue heron into the #2 engine, causing extensive damage. The pilot shut the engine down as a precaution and made an emergency landing. The runway was closed 38 minutes for cleaning. The flight was cancelled. The engine and nose cowl were replaced. Time out of service was 72 hours. The damage totaled $388,000.

14 June 2004. A Boeing 737 struck a great horned owl during a nighttime landing roll at Greater Pittsburgh International Airport (Pennsylvania). The bird severed a cable in the front main gear. The steering failed, and the aircraft ran off the runway and became stuck in mud. Passengers were bused to the terminal. Two nose wheels, two main wheels, and brakes were replaced. The aircraft was out of service 24 hours. The cost was estimated at $20,000.

16 September 2004. A MD 80 departing Chicago O'Hare (Illinois) hit several double-crested cormorants at 3,000 feet AGL and 4 miles from airport. The #1 engine caught fire and failed, sending metal debris to the ground in a Chicago neighborhood. The aircraft made an emergency landing back at O'Hare with no injuries to the 107 passengers. (See photo on page 21.)

24 October 2004. A Boeing 767 departing Chicago O'Hare (Illinois) hit a flock of birds during the takeoff run. A compressor stall caused the engine to flame out. A fire department got calls from local residents who reported seeing flames coming from the plane. The pilot dumped approximately 11,000 gallons of fuel over Lake Michigan before returning to land. Feathers found in engine were sent to the Smithsonian, Division of Birds, for identification.

Besides having the potential to cause damaging strikes, small mammals, such as this prairie dog at a southwestern USA airport, can create problems by burrowing, gnawing on wiring, and serving as a food attractant for large birds of prey.

2.7 CONCLUSIONS

Wildlife strikes can cause serious damage to aircraft and the occasional loss of human life. Because most strikes occur on or near airports, airports are the logical locations to place emphasis in addressing the problem. The following chapters and appendices, coupled with guidance from professional wildlife biologists trained in wildlife damage management, provide the information needed to develop, implement, and evaluate wildlife hazard management programs to minimize the likelihood of wildlife strikes on airports.

CHAPTER 3:
AGENCIES AND ORGANIZATIONS IMPACTING WILDLIFE HAZARD MANAGEMENT ON AIRPORTS

In December 2002, this Dash-8 struck a deer while landing at a southeastern USA airport. The impact caused the nose gear to collapse. The white-tailed deer population in the USA increased from a low of about 350,000 in 1900 to at least 24 million in 2004.

3.1 INTRODUCTION

Wildlife management is a complex mixture of science, experience, and art, regulated and implemented by various federal, state, and local governmental agencies. Overlapping federal, state, and local regulations enforced by various governmental organizations protect wildlife and associated wildlife habitat. This chapter provides an overview of the roles and responsibilities of various agencies and organizations that influence wildlife management on or near airports.

3.2 FEDERAL AGENCIES

3.2.A U.S. DEPARTMENT OF TRANSPORTATION, FEDERAL AVIATION ADMINISTRATION

3.2.A.I MISSION

The mission of the Federal Aviation Administration (FAA) is to provide a safe, secure, and efficient global aviation system that contributes to national security and the promotion of U.S. aviation. As the leading authority in the international aerospace community, the FAA is responsive to the dynamic nature of customer needs, economic conditions, and environmental concerns.

High-profile species such as bald eagles present special problems for airport managers (photo by E. Cleary, FAA).

3.2.A.II AUTHORITY

Since 1970, Section 612 of the Federal Aviation Act of 1958, as amended (49 U.S.C. 1432), has empowered the FAA Administrator to issue airport operating certificates to airports serving certain air carriers and to establish minimum safety standards for the operation of those airports. Some of these regulations and policies directly involve the management of wildlife and wildlife hazards on and/or near airports.

3.2.A.III ROLE AND RESPONSIBILITY

Among its other responsibilities, the FAA is responsible for enforcement of Title 14 Code of Federal Regulations, part 139 (14 CFR 139). To carry out this role, the FAA has responsibilities for various aspects of aviation that include air navigation, air traffic control, aviation certification and regulation, aviation security, environmental impact minimization, and aviation research and development.

The FAA roles and responsibilities relating to wildlife hazards and their associated human health and safety concerns are addressed in 14 CFR 139.337. The FAA's Office of Airport Safety and Standards' 150/5200 series Advisory Circulars (AC), Program Policy and Guidance, and Certalerts further clarify this information.

3.2.A.III.A OFFICE OF AIRPORT SAFETY AND STANDARDS

A staff wildlife biologist is assigned to the Office of Airport Safety and Standards, Washington, DC. The biologist works with airport operators and certificate holders through the FAA regional and district offices in matters related to wildlife hazards on airports. Responsibilities of the staff wildlife biologist include reviewing development plans of all certificated airports to minimize wildlife hazards; managing the wildlife aircraft strike database designed to document the history of reported strikes at airports throughout the USA and its territories; and serving as an internal consultant to the FAA on the appropriateness of Wildlife Hazard Management Plans, wildlife hazard research, and other wildlife management issues of concern to the FAA.

Airport operators are required to conduct a Wildlife Hazard Assessment when wildlife capable of causing substantial aircraft damage are observed to have access to the aircraft movement area (photo courtesy USDA).

The FAA staff wildlife biologist examines all wildlife aircraft strike reports submitted to the FAA. Copies of major strike reports (14 CFR 139.337(b)(1-4)), together with the strike history for the particular airport, are forwarded to the appropriate FAA regional personnel. See also FAA Office of Airport Safety and Standards' Policies and Program Guidance Policy No. 79, *Review of Airport Wildlife Hazard Management Plans* (Appendix D).

3.2.A.III.B Wildlife hazard assessments

Operators of certificated airports are required by regulation to conduct a Wildlife Hazard Assessment when specific wildlife events occur, as discussed in Chapter 6 (14 CFR 139.337(b)(1-4), see Appendix P). FAA Office of Airport Safety and Standards' Program Policy and Guidance No. 77, *Initiation of Wildlife Hazard Assessments at Airports* (Appendix D), establishes the procedures followed by FAA Airport Certification Safety Inspectors when it is determined that an airport needs to conduct a Wildlife Hazard Assessment. Under terms of the Memorandum of Understanding between the FAA and U.S. Department of Agriculture, Wildlife Services (USDA/WS, Appendix G), the USDA/WS program can provide assistance with the conduct of Wildlife Hazard Assessments and the development of Wildlife Hazard Management Plans. FAA Office of Airport Safety and Standards' Certalert No. 04-09, Relationship Between FAA and WS (Appendix E), further clarifies the roles of, and relationship between, the FAA and USDA/WS with regard to wildlife hazards on or near airports. See Chapter 6 for a discussion of the contents of a Wildlife Hazard Assessment.

3.2.A.III.C Wildlife hazard management plans

The FAA Administrator considers the Wildlife Hazard Assessment, aeronautical activity at the airport, views of the airport operator and its users, and other pertinent factors in determining whether a Wildlife Hazard Management Plan is needed (14 CFR 139.337(d)(1-6), see Appendix P). See Chapter 6 for a discussion of the contents of a Wildlife Hazard Management Plan.

3.2.A.III.D Advisory Circulars (150/5200 Series)

The FAA issues Advisory Circulars (AC) to systematically inform the aviation public of nonregulatory material of interest. The standards, practices, and suggestions contained in AC are recommended by the FAA for use by the operators and sponsors of all public-use airports. An AC provides guidance and information in its designated subject area and/or shows methods acceptable to the FAA Administrator for complying with 14 CFR 139. Unless incorporated into regulation by reference, the contents of an AC are not binding on the public. FAA Advisory Circulars germane to airport wildlife issues can be found in Appendix C.

3.2.B U.S. DEPARTMENT OF AGRICULTURE, WILDLIFE SERVICES

Bayberry bushes produce fruits that often attract large flocks of tree swallows along the east coast of the USA during fall migration. Identifying and removing such preferred food plants is an important part of a wildlife hazard management control program (photo by R. A. Dolbeer, USDA).

3.2.B.I MISSION

The mission of the U.S. Department of Agriculture/Wildlife Services (USDA/WS) is to provide federal leadership in managing problems caused by wildlife. USDA/WS helps manage wildlife to reduce damage to agriculture, natural resources, and property; minimizes potential threats to human health and safety; and assists in the protection of threatened and endangered species.

3.2.B.II AUTHORITY

The primary statutory authority for the USDA/WS program is the Animal Damage Control Act of March 2, 1931, as amended (7 U.S.C. 426-426c; 46 Statute 1468)(See Appendix B).

USDA/WS has the authority to manage migratory bird damage only as specified in the Code of Federal Regulations and under permits issued by the U.S. Fish and Wildlife Service (USFWS) (50 CFR 21). USDA/WS does not have the authority to issue migratory bird depredation permits.

3.2.B.III ROLE AND RESPONSIBILITY

Wildlife is a public resource greatly valued by the citizens of the USA. However, wildlife can cause damage to agricultural and industrial resources, pose risks to human health and safety, and impact other natural resources. USDA/WS has the federal responsibility to help resolve conflicts that occur when human activity and wildlife are in proximity to one another. USDA/WS has primary responsibility of responding to threats caused by migratory birds.

Wildlife Services Directive 2.305, Wildlife Hazards to Aviation (Appendix F), provides guidance for USDA/WS wildlife biologists in providing technical assistance or direct control to airport managers, state aviation agencies, the aviation industry, the FAA, and the Department of Defense (DOD) on hazards caused by wildlife to airport safety.

USDA/WS assists federal, state, and local agencies; airport managers; the aviation industry; and the military in reducing wildlife hazards on and in the vicinity of airports and air bases according to the Memoranda of Understanding with the FAA (Appendix G) and Department of Defense and guidelines published elsewhere.

In addition, it is the responsibility of USDA/WS personnel that observe existing or potential wildlife hazards at airports or air bases to immediately notify the appropriate aviation authorities.

USDA/WS may enter into cooperative agreements to develop Wildlife Hazard Assessments and Wildlife Hazard Management Plans and to conduct direct wildlife hazard reduction programs. These activities are performed pursuant to agreements that are funded by cooperating entities.

USDA/WS biologists may provide training for airport and air base personnel in wildlife and hazard identification and the safe and proper use of wildlife control equipment and techniques.

Birds are not the only wildlife that pilots must watch out for. Proper fencing would have prevented this incident.

USDA/WS biologists may provide recommendations and assistance to airport managers and air base commanders in obtaining federal, state, and local permits to remove protected wildlife species.

3.2.C U.S. DEPARTMENT OF DEFENSE

3.2.C.I MISSION

The U.S. Department of Defense (USDOD) is responsible for providing the military forces needed to deter war and protect the security of the USA.

3.2.C.II AUTHORITY

The USDOD is the successor agency to the National Military Establishment created by the National Security Act of 1947 (50 U.S.C. 401). It was established as an executive department of the Government by the National Security Act Amendments of 1949 with the Secretary of Defense as its head (5 U.S.C. 101). The USDOD's primary authority is established under 32 CFR 1-2900.

3.2.C.III ROLE AND RESPONSIBILITY

Each military department (Department of the Navy includes the U.S. Marine Corps) is separately organized under its own Secretary and functions under the authority, direction, and control of the Secretary of Defense. The commanders of unified and specified combat commands are responsible to the President and the Secretary of Defense for accomplishing the military missions assigned to them and exercising command authority over forces assigned to them.

The U.S. Air Force (USAF) Bird Aircraft Strike Hazard (BASH) Team, HQ Air Force Safety Center, Kirtland Air Force Base, New Mexico, oversees the USAF wildlife strike reduction efforts. The BASH team maintains a wildlife strike database for strikes involving USAF aircraft (http://afsafety.af.mil/afsc/Bash/home.html) similar to the database maintained by the FAA for civil aircraft (Chapter 2).

3.2.D U.S. ARMY CORPS OF ENGINEERS

3.2.D.I MISSION

The U.S. Army Corps of Engineers (COE) is charged with a wide range of functions related to water resources. Among these is the protection of navigation and safeguarding the nation's water resources.

3.2.D.II AUTHORITY

Regulatory authorities of the COE include Section 10 of the Rivers and Harbors Act of 1899 (33 U.S.C. 403), which prohibits the obstruction or alteration of navigable waters of the U.S. without a COE permit; Section 404 of the Clean Water Act (33 U.S.C. 1344), which regulates the excavation and discharge of dredged or fill materials into waters of the U.S.; and Section 103 of the Marine Protection, Research, and Sanctuaries Act of 1972, which regulates deposition of fill material into ocean waters.

Recognizing that landfills can attract hazardous birds, the USEPA requires municipal solid waste landfills to be operated in a manner that does not pose a hazard to aviation safety (photo by E. Cleary, FAA).

3.2.D.III ROLE AND RESPONSIBILITY

The COE regulatory branch administers a permit system under Section 404 of the Clean Water Act. All proposed management actions involving any wetland habitat modification or excavation of fill material from or discharged into waters of the USA must be evaluated for Section 404 applicability and permit requirements. Projects requiring permits might require mitigation of impacted resources.

3.2.E U.S. ENVIRONMENTAL PROTECTION AGENCY

3.2.E.I MISSION

The mission of the U.S. Environmental Protection Agency (USEPA) is to safeguard the nation's environment.

3.2.E.II AUTHORITY

The USEPA was established in 1970 in response to concerns about polluted air and rivers, unsafe drinking water, endangered species, and waste disposal. The USEPA's primary regulatory responsibilities are established under 40 CFR 1-799.

3.2.E.III ROLE AND RESPONSIBILITY

USEPA functions include setting and enforcing environmental standards and regulations related to air and water pollution, hazardous wastes, pesticides, and toxic substances. The USEPA's mission is accomplished through partnerships with state and local governments. USEPA responsibilities include pesticide registration and regulation and siting and construction of wastewater treatment and solid waste disposal facilities, which are permitted through state and local agencies. The FAA and USDA/WS may be consulted by airport authorities or state and local agencies to review impacts of proposed USEPA-regulated projects on aviation safety.

3.2.E.III.A LANDFILLS

Approval or disapproval of a landfill site is the responsibility of the USEPA, state and local governing bodies, and zoning boards. Other federal agencies, such as the FAA and USDA/WS, may only comment as to whether they would consider the proposed landfill to be compatible or non-compatible with their mission requirements.

3.2.E.III.B PESTICIDES

As one facet of an integrated hazardous wildlife management program, licensed falconers may occasionally use trained raptors, such as this peregrine falcon, at airports to repel other birds (photo by E. Cleary, FAA).

Before any pesticide may be used, it must be registered with the USEPA and with the appropriate state pesticide regulating authority. Pesticides are generally classified as either restricted use or general use. Restricted-use pesticides may only be sold to and used by Certified Applicators or persons under their direct supervision and only for those uses covered by the Certified Applicator's certification. There are few restrictions on who may purchase or use general-use pesticides. Persons who want to use restricted-use pesticides, apply any pesticide to the land of another, or apply any pesticides for hire must be a Certified Applicator or working under the direct supervision of a Certified Applicator, and then only use pesticides covered by the Certified Applicator's certification (see state EPA below).

3.2.F U.S. DEPARTMENT OF INTERIOR, U.S. FISH AND WILDLIFE SERVICE

3.2.F.I MISSION

The mission of the U.S. Fish and Wildlife Service (USFWS) is to conserve, protect, and enhance the nation's fish and wildlife and their habitats for the continuing benefit of all people.

3.2.F.II AUTHORITY

The USFWS has management authority for migratory birds and federally listed threatened and endangered wildlife species. The USFWS primary regulatory responsibilities are established under 50 CFR 1-199.

3.2.F.III Role and Responsibility

The USFWS is responsible for the conservation and enhancement of migratory birds, threatened and endangered species, certain marine mammals, anadromous fishes, and wetlands. The USFWS also manages the National Wildlife Refuge System, enforces federal wildlife laws, and conducts biological reviews of the environmental impacts of development projects.

Most mammals are protected by state wildlife agencies, and it is generally necessary to obtain a State Depredation Permit before taking these species on an airport. The first step in obtaining such a permit is to contact the nearest office of USDA Wildlife Services (see Appendix A).

The USFWS renders biological opinions on proposed federal activities that might impact federally listed or proposed endangered or threatened species or result in the destruction or adverse modification of designated or proposed critical habitat. These opinions are solicited through a "Section 7 consultation", as required under the Endangered Species Act of 1973 (16 U.S.C. 1531-1544, 87 Statute 884, as amended).

3.3 State Agencies

Specific state regulations and their enforcement are not addressed in this manual because of their wide variability. The following general comments are provided as background information.

Consult state and local regulatory agencies having jurisdiction over wildlife and natural resources, environmental protection, health, law enforcement, transportation, and others as applicable, when working with airport wildlife issues.

3.3.A State Wildlife Management Agencies

Wildlife management authority for resident nonmigratory birds, terrestrial mammals, freshwater fish, reptiles, and other taxa rest with state wildlife management agencies. These agencies establish the take and possession regulations for all state-protected species. States set their migratory game-bird hunting seasons and bag limits within the guidelines established by the USFWS. States also may list certain wildlife and plant species as threatened or endangered that are not considered as such at the federal level.

Persons needing to take state-protected species outside of the legal hunting season or beyond the established bag limits to promote airport safety must first secure a state depredation permit. Contact the nearest USDA/WS office (Appendix A) for assistance in obtaining any necessary state depredation permits.

3.3.B State Environmental Protection Agencies

3.3.B.I Landfill siting permits and inspections

With concurrence from the USEPA, state EPAs, local governing bodies, and zoning boards have the final responsibility for issuing landfill permits. It is also a state responsibility to inspect all landfills to ensure compliance with all applicable federal and state regulations.

3.3.B.II Pesticide registration

Before a pesticide may be sold or used, it must be registered with the USEPA and with the respective state's pesticide regulatory agency. Special Local Need (SLN) registered pesticides may only be used in the state—and in some cases, the specific geographical location—for which the SLN registration has been issued.

3.3.B.III Pesticide applicator licensing

With USEPA concurrence, each state is responsible for establishing pesticide applicator licensing requirements and applicator training procedures. The retail sale and use of restricted-use pesticides is limited to Certified Applicators or persons working under their direct supervision and only for those uses covered by the Certified Applicator's certification.

Within 2 weeks of completion, starlings and pigeons had started roosting in this canopy constructed over the passenger drop-off area at a major USA airport (photo by S. Gordon).

Anyone who uses restricted-use pesticides, applies any pesticides for hire, or applies any pesticide to the land of another must be a Certified Applicator or working under the direct supervision of a Certified Applicator, and may only use pesticides covered by the Certified Applicator's certification.

3.4 Airports

3.4.A Airport operator

The operator of a certificated airport[1] must demonstrate that the airport is properly and adequately equipped and programs are in place to provide a safe airport-operating environment in accordance with all sections of 14 CFR 139 subpart D. Included in this regulation is the need to address

[1] Airports that have received an Airport Operating Certificate from the FAA, issued under 14 CFR 139, to operate a Class I, II, III, or IV airport.

wildlife hazard issues, conduct Wildlife Hazard Assessments, and develop Wildlife Hazard Management Plans, as conditions dictate.

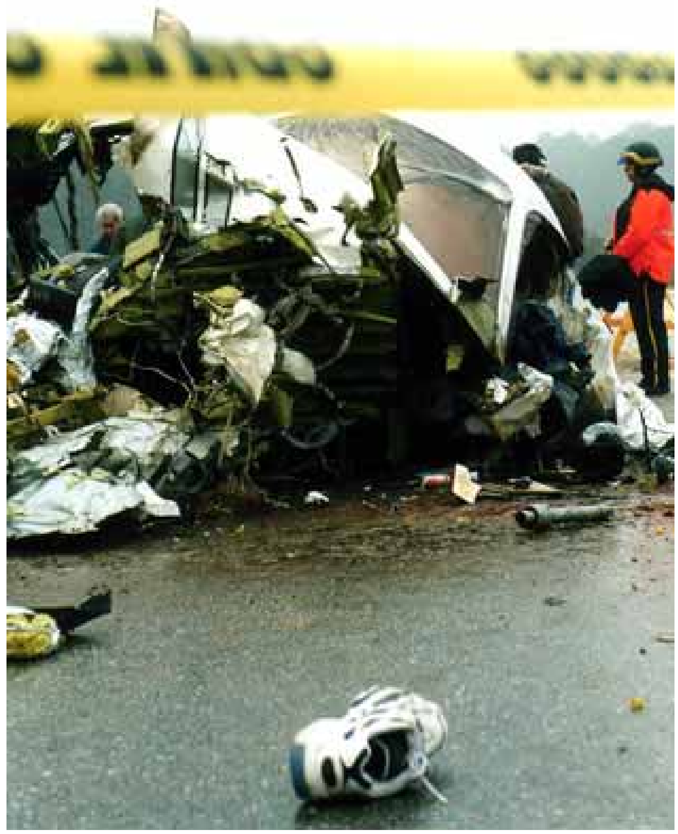
In accordance with its Airport Certification Manual and the requirements of section 139.337(a), each certificate holder must take immediate action to alleviate wildlife hazards whenever they are detected. An important part of this process is establishing procedures for airport employees or tenants to report hazardous wildlife on or near the air operation areas (AOA) to the appropriate airport personnel.

3.4.B AIR TRAFFIC CONTROL

Air traffic control personnel must report any unsafe conditions, including hazardous wildlife on or near the AOA, to the appropriate airport personnel anytime they are observed.

Also, to the extent permitted by higher priority duties and other circumstances, air traffic controllers are required to—

- Issue advisory information on pilot-reported, tower-reported, or radar-observed and pilot-verified bird activity;
- Relay bird activity information to adjacent facilities and to Flight Service Stations (FSS) whenever it appears the wildlife hazard will become a factor in the area (FAA Order 7110.65, 2-1-22).



Pilots using uncontrolled airports need to be alert to the possibility of wildlife on the runway. This Learjet was destroyed when it struck two deer on landing at a southern USA airport, January 2001. In 2004, there were 3,344 airports in the FAA's National Plan of Integrated Airport Systems; less than 650 had an air traffic control tower.

3.4.C PILOTS

Pilots have a responsibility to report all unsafe conditions on or near an airport, including birds or other wildlife that could pose a threat to aircraft safety. Pilots and other airline or airport personnel should report all known wildlife strikes. Strikes can be reported electronically at http://wildlife-mitigation.tc.faa.gov. Wildlife strikes can also be reported by completing and mailing FAA Form 5200-7 *Bird/Other Wildlife Strike Report* (Appendix I). No postage is required if this form is mailed within the USA. This form can be downloaded and printed from the above website and duplicated as needed. All strike reports are closely screened and edited to prevent duplicate entries in the database.

3.5 BIRD STRIKE COMMITTEE–USA

Bird Strike Committee–USA (BSC–USA) was formed in 1991 to facilitate the exchange of information, promote the collection and analysis of accurate wildlife strike data, promote the development of new technologies for reducing wildlife hazards, promote professionalism in wildlife management programs on airports through training and advocacy of high standards of conduct of airport biologists and bird patrol personnel, and serve as a liaison to similar organizations in other countries.

Bird Strike Committee USA is directed by a 9- to 12-person steering committee consisting of two to three members each from the FAA, USDA/WS, DOD, and the aviation industry. The organization meets annually, in conjunction with Bird Strike Committee Canada, at an airport in the USA or Canada. There are generally four parts to a BSC–USA meeting. Part 1 is classroom and field training sessions on wildlife control at airports, which cover both civil and military aviation. Part 2 consists of the presentation of technical papers and posters. Part 3 comprises exhibits and demonstrations with vendors. Part 4 is a field trip that generally covers the host airport and surrounding areas to observe management programs and habitat issues related to wildlife and aviation safety. Participation in the annual meetings is open to any person interested in reducing wildlife hazards to aviation and in environmental and land-use issues related to airports. BSC–USA does not charge membership fees; however, a registration fee is charged for attendance at annual meetings.

Between 1990 and 2003, deer were responsible for 16 (76 percent) of the mammal strikes that resulted in injury or death and for 23 (77 percent) of the 30 deaths or injuries resulting from wildlife strikes with civil aircraft in the USA (photo by S. Wright, USDA).

Additional information about BSC–USA can be found at BSC–USA's website: http://www.birdstrike.org.

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CHAPTER 4:
FEDERAL REGULATIONS AND DEPARTMENTAL POLICIES IMPACTING AIRPORT WILDLIFE MANAGEMENT

Four men escaped unhurt when their Learjet 36 struck an elk and caught fire during takeoff at a western USA airport in December 2002. The pilot was able to bring the plane to a stop in a marsh just off the end of the runway and evacuate the aircraft before it was destroyed by fire.

4.1 INTRODUCTION

Wildlife is often protected by overlapping federal, state, and local laws, regulations, and ordinances, enforceable by a diversity of governmental organizations. Chapter 3 provided an overview of the roles and responsibilities of the various agencies. This chapter will discuss some of the more important federal regulations and departmental policies that influence wildlife management on or near airports.

4.2 SUMMARY OF APPLICABLE FEDERAL REGULATIONS

4.2.A TITLE 14, CODE OF FEDERAL REGULATIONS, PART 139

14 CFR 139 governs the certification and operation of land airports that serve any scheduled or unscheduled passenger operation of an air carrier that is conducted with an aircraft having a seating capacity of more than 9 passengers. Part 139.337 (Appendix P) speaks specifically to the airport operator's responsibilities when dealing with the reduction of wildlife strike hazards on and around airports. A detailed discussion of Part 139.337 can be found in Chapter 6.

4.2.B TITLE 40, CODE OF FEDERAL REGULATIONS, PART 258.10

The U.S. Environmental Protection Agency (USEPA), recognizing that birds can be attracted in large numbers to municipal solid waste landfills (MSWLF) and recognizing the potential threat posed by birds to aircraft safety, requires owners or operators of new MSWLF units—or lateral expansions of existing MSWLF units that are located within 10,000 feet of any airport runway used by turbojet aircraft or within 5,000 feet of any airport runway used only by piston-type aircraft—to demonstrate successfully that such units do not create hazardous conditions for aircraft.

Because of conservation efforts by government agencies and private organizations, many wildlife species once on the brink of extinction are now on the road to recovery. This juvenile bald eagle, hatched in New York, was rescued after a storm in Indiana. Management of migratory bird species is the responsibility of the USFWS (photo by E. Cleary, FAA).

The USEPA also requires any operator proposing a new or expanded waste disposal operation within 5 statute miles of a runway end to notify the appropriate FAA Regional Airports Division Office and the airport operator of the proposal.

4.2.C TITLE 50, CODE OF FEDERAL REGULATIONS, PARTS 1 TO 199

These regulations govern the management of federally protected wildlife within the United States and its territories based on the authority established in the Migratory Bird Treaty Act (see below). These regulations also establish procedures for issuing permits to take federally protected species. In general, a federal depredation permit, issued by the U.S. Fish and Wildlife Service (USFWS), must be obtained before any non-game migratory birds may be taken, or before any migratory game birds may be taken outside of the normal hunting season or beyond established bag limits.

Federal law protects all migratory birds, including their nests and eggs:

"A migratory bird [is]…any bird whatever its origin and whether or not raised in captivity, which belongs to a species listed in sect. 10.13 [of 50 CFR] or which is a mutation or a hybrid of any such species, including any part, nest, or egg of any such bird, or any product, whether or not manufactured, which consist, or is composed in whole or part, of any such bird, or any part, nest, or egg there of." (50 CFR 10.12). This list includes almost all native bird species in the United States, with the exception of nonmigratory game birds, such as turkeys and grouse, and some introduced game birds, such as pheasants and chukars. Exotic and feral species, such as graylag geese, muscovy ducks, European starlings, house (English) sparrows, and rock doves (pigeons), are not listed in 50 CFR 10.13 and are therefore not protected by federal law.

In addition to federal protection, all states protect migratory birds as well as game birds, such as pheasants, turkeys, grouse, and partridges. States might or might not protect exotic or feral species.

With the exception of federally listed or proposed threatened or endangered species, federal law does not protect terrestrial mammals, reptiles, or other wildlife taxa (e.g., deer, coyotes, raccoons, groundhogs, snakes, turtles, and freshwater fish). Protection of these wildlife groups is left to the individual states.

Blackbirds traveling to and from roosting sites near an airport can create hazardous conditions for aircraft. A federal permit is not required to control blackbirds when "concentrated in such numbers and manner as to constitute a health hazard or other nuisance” (photo by R. A. Dolbeer, USDA).

4.2.C.I Depredation permitting requirements and procedures

Persons wishing to take migratory birds, nests, or eggs as part of an airport wildlife management program must first secure a depredation permit from the USFWS. Some state wildlife management agencies may require that a state permit be obtained also. Persons wishing to take state-protected species must first secure a permit from their respective state wildlife management agency. For assistance in obtaining federal and state depredation permits, contact the local U.S. Department of Agriculture, Wildlife Services (USDA/WS) office (Appendix A).

4.2.C.II Standing depredation orders

Federal law allows people to protect themselves and their property from damage caused by migratory birds. Provided no effort is made to kill or capture the birds, a depredation permit is not required to merely scare or herd depredating migratory birds other than endangered or threatened species or bald or golden eagles (50 CFR 21.41).

In addition, certain species of migratory birds may be killed or captured without a federal permit under specific circumstances, most of which relate to agricultural situations. A Standing Depredating Order that has applicability at airports relates to blackbirds and related species:

"A federal permit shall not be required to control yellow-headed, red-winged, rusty and Brewer's blackbird, cowbirds, all grackles, crows, and magpies, when found committing or about to commit depredation upon ornamental or shade trees, agricultural crops, livestock, or wildlife, or when concentrated in such numbers and manner as to constitute a health hazard or other nuisance …" (50 CFR 21.43).

This Navy T-44A suffered a turkey vulture strike to the right horizontal stabilizer during a routine training flight in October 2002 in Texas. The T-44A is the U.S. Navy's version of a Beechcraft King Air 90, a twin turboprop corporate and utility transport aircraft. The turkey vulture population in the USA increased at a mean annual rate of over 2% from 1980–2004.

However, state laws may not mirror federal law in this respect. For example, in Ohio, crows may not be killed in any circumstances, outside of the state crow-hunting season, without a state-issued depredation permit, and blackbirds may not be killed on Sundays.

Persons wishing to take any other migratory birds, or to take migratory birds in situations other than those described above, must first secure a federal Migratory Bird Depredation Permit from the USFWS, and in some case a State Depredation Permit. The first step in obtaining the necessary permits is to contact the nearest USDA/WS state office (Appendix A).

4.2.D THE MIGRATORY BIRD TREATY ACT OF 1918, AS AMENDED (U.S. CODE 603–711; 40 STATUTE 755)

The United States of America, Canada, the United Mexican States, Russia and Japan are signatories to the Migratory Bird Treaty Act (MBTA). This act provides the statutory foundation for the federal protection and management of migratory birds in the United States (50 CFR, Parts 1–199).

4.2.E THE ANIMAL DAMAGE CONTROL ACT OF 1931, AS AMENDED (7 U.S. CODE 426–426C; 46 STATUTE 1468)

This act authorizes and directs the Secretary of Agriculture to manage wildlife injurious to agricultural interests, other wildlife, or human health and safety, including wildlife hazards to aviation (Appendix B). The U.S. Department of Agriculture's Wildlife Services (USDA/WS) is the agency that carries out this mandate. USDA/WS, because of the experience, training, and background of its personnel, is recognized throughout the world for expertise in dealing with wildlife damage management issues. USDA/WS has an active presence in all U.S. states and territories. USDA/WS also has a National Wildlife Research Center in Colorado and eight regional research field stations.

4.2.F FEDERAL INSECTICIDE, FUNGICIDE, AND RODENTICIDE ACT, AS AMENDED (7 U.S. CODE 136; PUBLIC LAW 104.317)

This act, administered by USEPA, governs the registration, labeling, classification, and use of pesticides. Any substance used as a pesticide must be registered with the USEPA and with the respective state pesticide-regulatory agency. Anyone wishing to use restricted-use pesticides, applying any pesticides to the land of another, or applying any pesticides for hire, must be a Certified Applicator, or working under the direct supervision of a Certified Applicator, and then may only use pesticides covered by the Certified Applicator's certification.

This engine on an A320 ingested a great blue heron on departure from a western USA airport in 2002. The pilot observed the bird just prior to impact. The aircraft made an emergency landing with the engine out. The engine and nose cowl were replaced. The runway was closed for 38 minutes while fire trucks washed the debris from the runway (photo courtesy S. Gordon).

4.3 DEPARTMENTAL POLICIES

4.3.A FAA ADVISORY CIRCULARS

The FAA recommends that public-use airport operators implement the standards and practices contained in all applicable Advisory Circulars (AC). Holders of Airport Operating Certificates issued under Title 14, Code of Federal Regulations (CFR), Part 139, Certification of Airports, Subpart D (Part 139), may use the standards, practices, and recommendations contained in an AC to comply with the airport management requirements of Part 139. In general, airports that have received federal grant-in-aid assistance must use the standards presented in an AC. See Appendix C for copies of the current version (as of July 2005) of AC mentioned in this Manual. AC are revised on an irregular schedule. Copies of revised AC can be accessed at: http://www.faa.gov/arp/

4.3.A.I 150/5200-32A. REPORTING WILDLIFE AIRCRAFT STRIKES.

This AC explains the importance of reporting wildlife strikes. It also examines recent improvements in the FAA's Bird/Other Wildlife Strike Reporting system, how to report a wildlife strike, what happens to the wildlife strike report data, how to access the FAA National Wildlife Aircraft Strike Database, and the FAA's Feather Identification Program.

4.3.A.II 150/5200-33A. HAZARDOUS WILDLIFE ATTRACTANTS ON OR NEAR AIRPORTS.

This AC provides guidance on locating certain land uses having the potential to attract hazardous wildlife to or in the vicinity of public-use airports. It also provides guidance on the placement of new airport development projects (including airport construction, expansion, and renovation) pertaining to aircraft movement in the vicinity of hazardous wildlife attractants.

4.3.A.III 150/5200-34. Construction or Establishment of Landfills near Public Airports.

This AC provides guidance on meeting the requirements of Section 503 of the Wendell H. Ford Aviation Investment and Reform Act for the 21st Century (Public Law 106–181) (AIR 21), which prohibits the construction or establishment of a new Municipal Solid Waste Landfill within 6 statute miles of certain public-use airports. Before these prohibitions apply, both the airport and the landfill must meet very specific conditions. These restrictions do not apply to airports or landfills located within the state of Alaska (see § 5.3.A.I of this manual).

Between 1990 and 2003, vultures were involved in 374 reported wildlife strikes to US civil aircraft; 219 (59%) of those strikes caused damage to the aircraft. Vultures readily feed at landfills (photo by M. Colunga, Aeropuertos y Servicios Auxiliares).

4.3.B FAA, Airports: Airport Certification Program Policies and Guidance

Program Policies and Guidance documents provide FAA personnel with interpretations of and directions for applying various aspects of federal regulations related to aviation safety. See Appendix D for Program Policies and Guidance related to airport wildlife management.

4.3.B.I Policy No. 77. Initiation of Wildlife Hazard Assessments at Airports.

This policy establishes the procedures for FAA Airport Certification Safety Inspectors to follow when it is determined that an airport needs to conduct a Wildlife Hazard Assessment to address an airport wildlife hazard.

4.3.B.II Policy No. 78. Section 7 Consultation on Endangered or Threatened Species.

This policy establishes the procedures for coordinating and documenting FAA compliance with the Endangered Species Act when requiring an airport operator to develop, submit for approval, and implement a Wildlife Hazard Management Plan.

4.3.B.III Policy No. 79. Review of Airport Wildlife Hazard Management Plans.

This policy establishes the procedures to be followed when an incident occurs that would initiate a Wildlife Hazard Assessment under 14 CFR 139.337(b)(1-4), and directs Airport Certification Safety Inspectors to review an airport's Wildlife Hazard Management Plan to ensure that it meets all requirements of 14 CFR 139.337(e) and (f), as part of their preparation for a certification inspection.

4.3.b.iv Policy No. 82. Waste disposal facility coordination.

This policy establishes the procedures for coordinating and documenting FAA determinations on developing new, or expanding existing, waste disposal sites within 5 miles of a public-use airport.

This retention pond, located less than 2,000 feet from the main runway at a major USA airport, had 3 duck and 1 Canada goose nests when surveyed in 2002 (photo by E. Cleary, FAA).

4.3.c FAA, Airports, Office of Airport Safety and Standards, Certalerts relating to airport wildlife management

Certalerts provide non-directive advisory or cautionary information dealing with aviation safety to the aviation community. See Appendix E for Certalerts dealing with aviation wildlife hazards.

4.3.c.i Certalert No. 98-05. Grasses attractive to hazardous wildlife.

This Certalert warns airport operators against the use of millet and any other large-seed producing grasses or other plants attractive to hazardous wildlife for revegetation of construction sites or other disturbed areas on the airport

4.3.c.ii Certalert No. 04-09. The relationship between FAA and USDA/WS.

This Certalert clarifies the roles of and relationship between the Federal Aviation Administration (FAA) and the United States Department of Agriculture, Animal and Plant Health Inspection Service, Wildlife Services (USDA/WS) with regards to wildlife hazards on or near airports.

4.3.c.iii Certalert No 04-16. Deer hazards to aviation and deer fencing.

In light of recent incidents where a Learjet landing at an airport in Alabama and a Learjet departing an airport in Oregon were destroyed after colliding with deer or elk, airport operators are reminded of the importance of controlling deer and other wild ungulates on and around airfields.

4.3.d USDA, Wildlife Services Directive 2.305, Wildlife Hazards To Aviation

This directive provides general guidelines for USDA/WS technical and direct control assistance to airport managers, state aviation agencies, aviation industry, FAA, and Department of Defense about hazards caused by wildlife to airport safety (Appendix F).

4.3.E MEMORANDUM OF UNDERSTANDING: FAA AND USDA/WS

A well-maintained fence, at least 10-feet high with no gaps at the bottom, is the primary defense to keep deer and other large animals off the airport's AOA. Deer can easily jump fences that are only 6 feet high (right) (photo by R. A. Dolbeer, USDA).

A Memorandum of Understanding between the FAA and USDA/WS (No. 12-14-71-0003-MOU), establishing a cooperative relationship between the two agencies, has been in effect since 1989. The FAA relies heavily on the assistance of USDA/WS for resolving problems involving wildlife hazards to aviation at airports (Appendix G).

4.3.F INTERAGENCY MEMORANDUM OF AGREEMENT

The Federal Aviation Administration, the U.S. Air Force, the U.S. Army Corps of Engineers, the U.S. Environmental Protection Agency, the U.S. Fish and Wildlife Service, and the U.S Department of Agriculture/Wildlife Services signed a Memorandum of Agreement (MOA) (finalized July 2003) to acknowledge their respective missions in protecting aviation from wildlife hazards. Through the MOA, the agencies established procedures necessary to coordinate their missions to address more effectively existing and future environmental conditions contributing to collisions between wildlife and aircraft (wildlife strikes) throughout the United States. These efforts are intended to minimize wildlife risks to aviation and human safety while protecting the Nation's valuable environmental resources (Appendix H).

CHAPTER 5: RECOGNIZING HAZARDOUS WILDLIFE ATTRACTANTS ON OR NEAR AIRPORTS

A Eurasian crane penetrated the windshield of this Israeli helicopter in March 2003. In the USA, vultures and waterfowl have been responsible for the most losses of military aircraft to bird strikes.

5.1 INTRODUCTION

Land-use practices and habitat are the key factors determining the wildlife species and the size of wildlife populations that are attracted to airport environments. The recognition and control of those land-use practices and habitats on or near airports that attract hazardous wildlife are fundamental to effective Wildlife Hazard Management Plans.

The FAA (through Advisory Circular 150/5200-33A, Hazardous Wildlife Attractants on or Near Airports, Appendix C) provides guidance on locating certain land uses that have the potential to attract hazardous wildlife on or near public-use airports. It also discusses airport development projects (including airport construction, expansion, and renovation) affecting aircraft movement near hazardous wildlife attractants.

5.2 SEPARATION CRITERIA FOR HAZARDOUS WILDLIFE ATTRACTANTS ON OR NEAR AIRPORTS

The minimum separation criteria outlined below are recommended for land-use practices that attract hazardous wildlife to the vicinity of airports. Please note that these criteria include land uses that cause movement of hazardous wildlife onto, into, or across the approach or departure airspace, air operation area (AOA), loading ramps, or aircraft parking area of airports.

Piston engines are not as susceptible to bird-strike damage as turbine engines. However, other parts of piston-powered aircraft can be severely damaged. This Rockwell Commander, flying at 1,500 feet AGL and 130 knots, struck a large bird. This was the second damaging bird strike this aircraft had suffered in less than 10 years (photo courtesy B. McKinnon, Transport Canada).

The basis for the separation criteria contained in this section can be found in existing FAA regulations. The separation distances are based on (1) flight patterns of piston-powered aircraft and turbine-powered aircraft, (2) the altitude at which most strikes happen (81 percent occur under 1,000 feet and 92 percent occur under 3,000 feet above ground level), and (3) National Transportation Safety Board (NTSB) recommendations. The recommended separation distances are diagramed in Figure-5-1.

5.2.A AIRPORTS SERVING PISTON-POWERED AIRCRAFT

Airports that do not sell Jet-A fuel normally serve piston-powered aircraft. Notwithstanding more stringent requirements for specific land uses, a minimum separation distance of 5,000 feet is recommended at these airports for known hazardous wildlife attractants or for new airport development projects meant to accommodate aircraft movement. This distance is to be maintained between an airport's AOA, loading ramps, and aircraft parking areas and the hazardous wildlife attractant. Figure 5-1 depicts this separation distance measured from the nearest AOA.

5.2.B AIRPORTS SERVING TURBAN-POWERED AIRCRAFT

Airports selling Jet-A fuel normally serve turbine-powered aircraft. Notwithstanding more stringent requirements for specific land uses, a minimum separation distance of 10,000 feet is recommended at these airports for known hazardous wildlife attractants or for new airport development projects meant to accommodate aircraft movement. This distance is to be maintained between an airport's AOA, loading ramps, and aircraft parking areas and the hazardous wildlife attractant. Figure 5-1 depicts this separation distance measured from the nearest AOA.

5.2.C PROTECTION OF APPROACH OR DEPARTURE AIRSPACE

For all airports, a minimum separation distance of 5 statute miles is recommended between the farthest edge of the airport's AOA and known hazardous wildlife attractant if the attractant could cause hazardous wildlife movement into or across the approach or departure airspace. Figure 5-1 depicts this separation distance measured from the nearest AOA.

5.3 LAND-USE PRACTICES THAT POTENTIALLY ATTRACT HAZARDOUS WILDLIFE

Because most agricultural crops attract birds at some point during their production cycle, the FAA recommends against allowing farming on airport property (photo by R. DeFusco, BASH, Inc.).

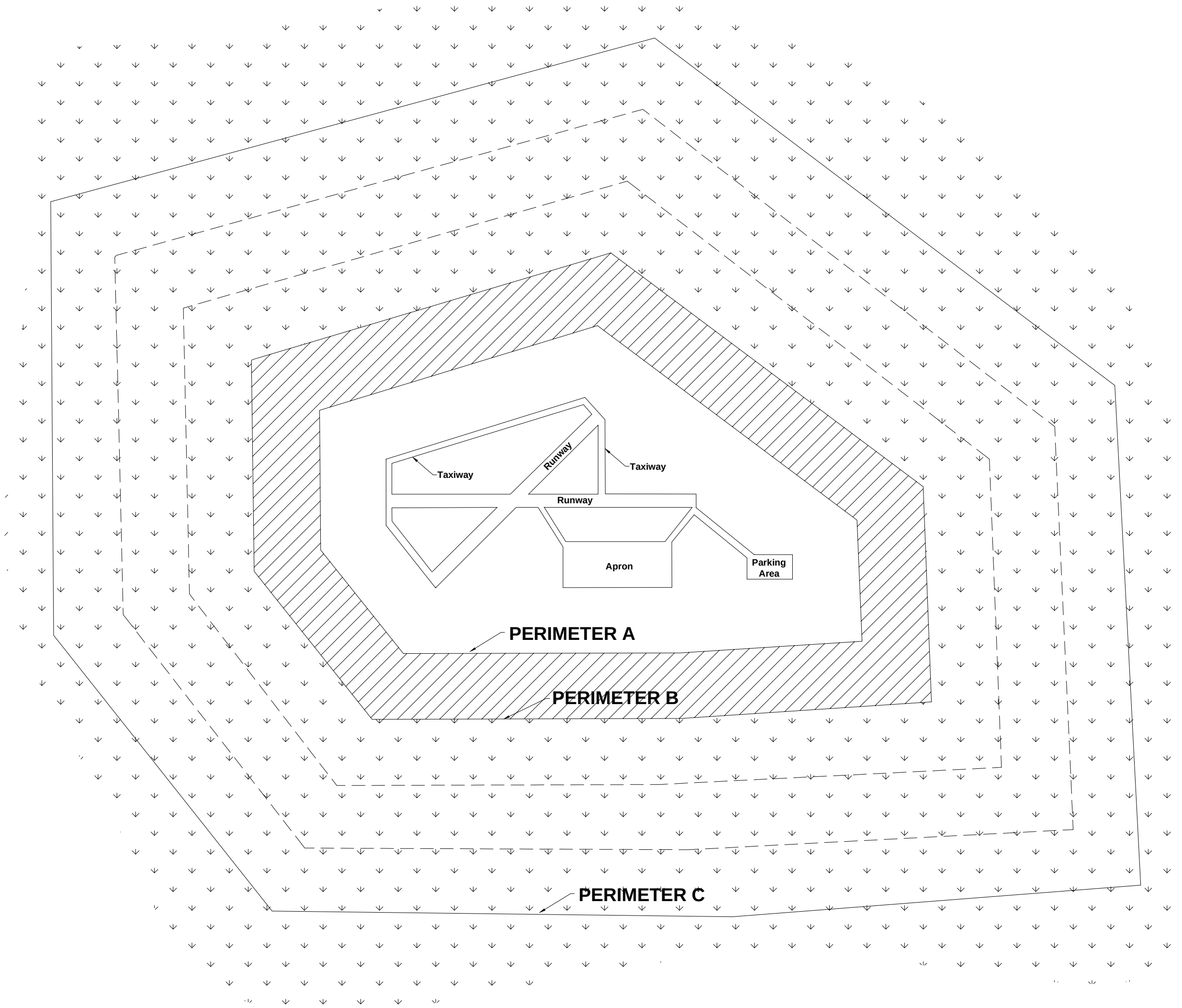
The wildlife species and the size of the populations attracted to the airport environment vary considerably, depending on several factors, including land-use practices on or near the airport. This section discusses land-use practices having the potential to attract hazardous wildlife and threaten aviation safety.

5.3.A WASTE DISPOSAL OPERATIONS

Municipal solid waste landfills (MSWLF) are known to attract large numbers of hazardous wildlife, particularly birds. Because of this, these operations, when located within the separations identified in the siting criteria in AC 150/5200-33A (see above and Appendix C), are considered incompatible with safe airport operations.

5.3.A.I SITING NEW MUNICIPAL SOLID WASTE LANDFILLS SUBJECT TO AIR 21

Section 503 of the Wendell H. Ford Aviation Investment and Reform Act for the 21st Century (Public Law 106–181) (AIR 21) prohibits the construction or establishment of a new MSWLF within 6 statute miles of certain public-use airports. Before these prohibitions apply, both the airport and the landfill must meet the very specific conditions described below. These restrictions do not apply to airports or landfills located within Alaska.



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.

Figure 5-1. Separation distances within which hazardous wildlife attractants should be avoided, eliminated, or mitigated.

The airport must (1) have received a federal grant(s) under 49 U.S.C. § 47101, et. seq.; (2) be under control of a public agency; (3) serve some scheduled air carrier operations conducted in aircraft with less than 60 seats; and (4) have total annual enplanements consisting of at least 51 percent of scheduled air carrier enplanements conducted in aircraft with less than 60 passenger seats.

The proposed MSWLF must (1) be within 6 miles of the airport, as measured from airport property line to MSWLF property line, and (2) have started construction or establishment on or after April 5, 2001. Public Law 106–181 only limits the construction or establishment of some new MSWLF. It does not limit the expansion, either vertical or horizontal, of existing landfills. Consult the most recent version of AC 150/5200-34, *Construction or Establishment of Landfills Near Public Airports* (Appendix C), for a more detailed discussion of these restrictions.

It is widely recognized that open-faced, putrescible waste landfills attract gulls. However, these landfills also attract other birds hazardous to aviation. Over 5,000 starlings were counted at this Midwestern USA landfill (photo by E. Cleary, FAA).

5.3.a.ii Siting New Municipal Solid Waste Landfills Not Subject to AIR 21

If an airport and MSWLF do not meet the restrictions of Public Law 106–181, do not locate new MSWLF within the separation distances identified in AC 150/5200-33A (see above and Appendix C). Measure the separation distances from the closest point of the airport's AOA to the closest planned MSWLF cell.

5.3.a.iii Considerations for Existing Waste Disposal Facilities within the Limits of Separation Criteria

Do not locate airport development projects that would increase the number of aircraft operations or accommodate larger or faster aircraft near MSWLF operations within the separations identified in AC 150/5200-33A (see above and Appendix C). In addition, in accordance with 40 CFR 258.10, owners or operators of existing MSWLF units that are located within the separations listed in AC 150/5200-33A (see above and Appendix C) must demonstrate that the unit is designed and operated so it does not pose a bird hazard to aircraft.

To claim successfully that a waste-handling facility sited within the separations identified in AC 150/5200-33A (see above and Appendix C) does not attract hazardous wildlife and does not threaten aviation, the developer must establish convincingly that the facility will not handle putrescible material other than in fully enclosed transfer stations (see 5.4.b, below).

In their effort to satisfy the EPA requirement, some putrescible-waste facility proponents might offer to undertake experimental measures to demonstrate that their proposed facility will not be a hazard to aircraft. To date, no such facility has been able to demonstrate an ability to reduce and sustain hazardous wildlife to levels that existed before the putrescible-waste landfill began operating. For this reason, the FAA does not consider the demonstration of experimental wildlife control at putrescible-waste landfills within the separation distances specified in AC 150/5200-33A to be an acceptable alternative to locating the landfill beyond the separation distances.

5.3.B TRASH TRANSFER STATIONS

Enclosed waste-handling facilities that receive garbage behind closed doors; process it via compaction, incineration, or similar manner; and remove all residue by enclosed vehicles generally are compatible with safe airport operations, provided they are not located on airport property or within the Runway Protection Zone (RPZ). Do not handle or store putrescible waste outside or in a partially enclosed structure accessible to hazardous wildlife at these facilities. Trash transfer facilities that leave the main doors open during normal operations, are open on one or more sides, that temporarily store uncovered quantities of municipal solid waste outside, that use semi-trailers that leak or have trash clinging to the outside, or that do not control odors by ventilation and filtration systems (odor masking is not acceptable) do not meet the FAA's definition of fully enclosed trash transfer stations. The FAA considers these facilities incompatible with safe airport operations if they are located closer than the separation distances specified in AC 150/5200-33A (see above and Appendix C).

Open-sided trash transfer stations attract gulls, starlings, and other birds that can pose a hazard to aviation safety. Any waste-management facility that has exposed putrescible waste must not be located closer to an airport than the separation distance specified in AC 150/5200-33A (Appendix C) (photo by L. Henze, USDA).

5.3.C COMPOSTING OPERATIONS ON OR NEAR AIRPORT PROPERTY

Composting operations that accept only yard waste (e.g., leaves, lawn clippings, or branches) generally do not attract hazardous wildlife. Sewage sludge, woodchips, and similar material are not municipal solid wastes and may be used as compost bulking agents. The compost, however, must never include food or other municipal solid waste. Do not locate composting operations on airport property. Do not locate off-airport property composting operations closer than the greater of the following distances: 1,200 feet from any AOA, loading ramp, or aircraft parking space or the distance called for by airport design requirements (see AC 150/5300-13, Airport Design). This spacing is meant to prevent material, personnel, or equipment from penetrating any Object Free Area (OFA), Obstacle Free Zone (OFZ), Threshold Siting Surface (TSS), or Clearway. Monitor composting operations located in proximity to the airport to ensure that steam or thermal rise does not adversely affect air traffic. On-airport disposal of compost by-products is not recommended.

5.3.D UNDERWATER WASTE DISCHARGES

The underwater discharge of any food waste (e.g., fish processing offal) within the separations identified in AC 150/15200-33A (see above and Appendix C) is not recommended because it could attract scavenging hazardous wildlife.

5.3.E RECYCLING CENTERS

Recycling centers that accept previously sorted non-food items, such as glass, newspaper, cardboard, or aluminum, are, in most cases, not attractive to hazardous wildlife and are acceptable.

Small recycling bins and compactor stations, properly maintained so that putrescible waste is covered at all times, are generally not attractive to birds (photos by E. Cleary, FAA).

5.3.F CONSTRUCTION AND DEMOLITION DEBRIS FACILITIES

Construction and demolition debris (C&D) landfills do not generally attract hazardous wildlife and are acceptable if maintained in an orderly manner, admit no putrescible waste, and are not co-located with other putrescible waste disposal operations. C&D landfills have similar visual and operational characteristics to putrescible waste disposal sites. When co-located with putrescible waste disposal operations, C&D landfills are more likely to attract hazardous wildlife because of the similarities between these disposal facilities. Site C&D landfills co-located with other putrescible waste disposal operations outside of the separations identified in AC 150/5200-33A (see above and Appendix C).

5.3.G FLY ASH DISPOSAL

The incinerated residue from resource recovery power/heat-generating facilities that are fired by municipal solid waste, coal, or wood is generally not a wildlife attractant because it no longer contains putrescible matter. Landfills accepting only fly ash are generally not considered to be wildlife attractants and are acceptable as long as they are maintained in an orderly manner, admit no putrescible waste of any kind, and are not co-located with other disposal operations that attract hazardous wildlife.

Since varying degrees of waste consumption are associated with general incineration (not resource recovery power/heat-generating facilities), the FAA considers the ash from general incinerators a regular waste disposal by-product and, therefore, a hazardous wildlife attractant if disposed of within the separation criteria outlined in AC 150/5200-33A (see above and Appendix C).

Water detention basins at airports, such as this French-drain system at an eastern USA airport, should be designed to completely drain within 48 hours after the design storm event (photo by R. A. Dolbeer, USDA).

5.4 WATER MANAGEMENT FACILITIES

Drinking water intake and treatment facilities, storm water and wastewater treatment facilities, associated retention and settling ponds, ponds built for recreational use, and ponds that result from mining activities often attract large numbers of potentially hazardous wildlife. To prevent wildlife hazards, land-use developers and airport operators might need to develop management plans, in compliance with local and state regulations, to support the operation of storm water management facilities on or near public-use airports to ensure a safe airport environment.

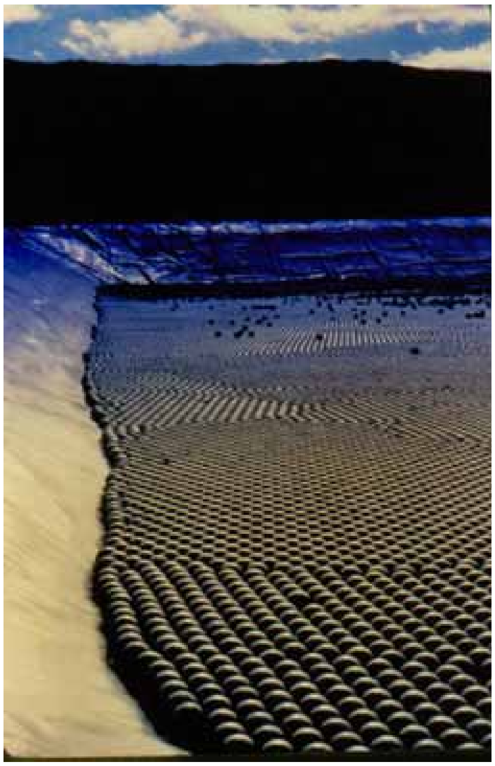
5.4.A EXISTING STORM WATER MANAGEMENT FACILITIES

On-airport storm water management facilities allow the quick removal of surface water, including discharges related to aircraft deicing, from impervious surfaces, such as pavement and terminal/hangar building roofs. Existing on-airport detention ponds collect storm water, protect water quality, and control runoff. Because they slowly release water after storms, they create standing bodies of water that can attract hazardous wildlife. Using appropriate wildlife hazard mitigation techniques, airport management should take immediate corrective actions to address any wildlife hazards arising from existing storm water or other such facilities located on or near an airport (14 CFR 139.337 (a)). Develop measures to minimize hazardous wildlife attraction in consultation with a wildlife damage management biologist.

This storm water basin was designed to drain within 48 hours following a major storm event (the design storm). The rip-rap lining helps prevent vegetation growth and bird use of the pond (photo courtesy FAA).

Where possible, modify storm water detention ponds to allow a maximum 48-hour detention period for the design storm. Avoid or remove retention ponds and detention ponds featuring long-term storage to eliminate standing water. Design or modify detention basins to remain totally dry between rainfalls. Where constant flow of water is anticipated through the basin, or where any portion of the basin bottom may remain wet, include a concrete or paved pad and/or ditch/swale in the bottom to prevent vegetation that may provide cover and food for wildlife.

When it is not possible to drain a large detention pond completely, use physical barriers, such as bird balls, wires grids, pillows, or netting, to deter birds and other hazardous wildlife. When physical barriers are used, carefully evaluate their use and ensure they will not adversely affect water rescue. Before installing any physical barriers over detention ponds on Part 139 airports, get approval from the appropriate FAA Regional Airports Division Office.



Floating plastic balls can be used to cover ponds and prevent birds from using the site. FAA approval is required before physical barriers may be used over ponds at certificated airports (photo courtesy Wildlife Materials, Inc.).

Encourage off-airport storm water treatment facility operators to incorporate appropriate wildlife hazard mitigation techniques into storm water treatment facility operating practices when their facility is located within the separation criteria specified in AC 150/5200-33A (see above and Appendix C).

5.4.B NEW STORM WATER MANAGEMENT FACILITIES

Design and operate off-airport storm water management systems located within the separations identified in AC 150/5200-33A (see above and Appendix C) so as not to create above-ground standing water. Design, engineer, construct, and maintain on-airport storm water detention ponds for a maximum 48–hour detention period for the design storm and so the ponds remain completely dry between storms. Use steep-sided, narrow, linearly shaped water detention basins to facilitate the control of hazardous wildlife. When it is not possible to place these ponds away from the AOA, use physical barriers, such as bird balls, wires grids, pillows, or netting, to prevent access of hazardous wildlife to open water and minimize aircraft-wildlife interactions. When physical barriers are used, carefully evaluate their use and ensure they will not adversely affect water rescue. Before installing any physical barriers over detention ponds on Part 139 airports, get approval from the appropriate FAA Regional Airports Division Office. Eliminate all vegetation in or around detention basins that provides food or cover for hazardous wildlife. If soil conditions and other requirements allow, use underground storm water infiltration systems, such as French drains or buried rock fields, because they are less attractive to wildlife.

5.4.C EXISTING WASTEWATER TREATMENT FACILITIES

In tropical regions, cattle egrets appear to fill the ecological niche occupied by gulls at waste management facilities in North America. Over 13,000 cattle egrets were seen at this sewage treatment and landfill complex near Mexico City (photo by E. Cleary, FAA).

Immediately correct any wildlife hazards arising from existing wastewater treatment or similar facilities located on or near the airport (14 CFR 139.337). Encourage wastewater treatment facility operators to incorporate measures, developed in consultation with a wildlife damage management biologist, to minimize hazardous wildlife attractants. Encourage wastewater treatment facility operators to incorporate these mitigation techniques into their standard operating practices. In addition, consider the existence of wastewater treatment facilities when evaluating proposed sites for new airport development projects and avoid such sites when practicable.

5.4.D NEW WASTEWATER TREATMENT FACILITIES

Do not construct new wastewater treatment facilities or associated settling ponds within the separations identified in AC 150/15200-33A (see above and Appendix C). Wastewater treatment facilities are “any devices and/or systems used to store, treat, recycle, or reclaim municipal sewage or liquid industrial wastes.” The definition includes any pretreatment involving the reduction of the amount of pollutants or the elimination of pollutants prior to introducing such pollutants into a publicly owned treatment works (wastewater treatment facility). Consider the potential to attract hazardous wildlife during the site-location analysis for wastewater treatment facilities if an airport is in the vicinity of the proposed site. Oppose such facilities if they are within the separations identified in AC 150/5200-33A (see above and Appendix C).

5.4.E ARTIFICIAL MARSHES

In warmer climates, wastewater treatment facilities sometimes employ artificial marshes and use submergent and emergent aquatic vegetation as natural filters. These artificial marshes may be used by various species of birds, such as blackbirds and waterfowl, for nesting, feeding, or roosting. Do not establish artificial marshes within the separations identified in AC 150/5200-33A (see above and Appendix C).

5.4.F WASTEWATER DISCHARGE AND SLUDGE DISPOSAL

Do not discharge of wastewater or sludge on airport property because it may improve soil moisture and quality on unpaved areas and lead to improved turf growth that can be an attractive food source for many species of animals. Also, the turf requires more frequent mowing, which in turn might mutilate or flush insects or small animals and produce thatch, both of which can attract hazardous wildlife. In addition, the improved turf might attract grazing wildlife, such as deer and geese. Problems might also occur when discharges saturate unpaved airport areas. The resultant soft, muddy conditions can severely restrict or prevent emergency vehicles from reaching accident sites in a timely manner.

5.5 WETLANDS

Wetlands provide a variety of functions and can be regulated by local, state, and federal laws. Wetlands typically attract diverse species of wildlife, including many that rank high on the list of hazardous wildlife species (Table 7-1).

If questions exist as to whether an area qualifies as a wetland, contact the local division of the U.S. Army Corps of Engineers, the Natural Resources Conservation Service, or a wetland consultant qualified to delineate wetlands. A MOA among six federal agencies was signed in 2003 (Appendix H) to facilitate, among other things, resolution of wetland management issues at airports without compromising aviation safety related to wildlife hazards.

This photo is from a National Wildlife Refuge located adjacent to a major USA airport (note air traffic control tower in background). These incompatible land uses were established years ago, before the FAA had set minimum separation distances. In this type of situation, both the airport manager and the refuge manager must be extra vigilant and ready to respond to rapidly developing wildlife hazard conditions (photo by E. Cleary, FAA).

5.5.A EXISTING WETLANDS ON OR NEAR AIRPORT PROPERTY

If wetlands are located on or near airport property, be alert to any wildlife use or habitat changes in these areas that could affect safe aircraft operations. At public-use airports, immediately correct, in cooperation with local, state, and federal regulatory agencies, any wildlife hazards arising from existing wetlands located on or near airports. Where required, a Wildlife Hazard Management Plan (WHMP) will outline appropriate wildlife hazard mitigation techniques. Develop measures to minimize hazardous wildlife attraction in consultation with a wildlife damage management biologist.

5.5.B NEW AIRPORT DEVELOPMENT

Whenever possible, locate new airports using the separations from wetlands identified in AC 150/5200-33A (see above and Appendix C). Where alternative sites are not practicable, or when expanding an existing airport into or near wetlands, in consultation with a wildlife damage management biologist, the U.S. Fish and Wildlife Service, the U.S. Army Corps of Engineers, and the state wildlife management agency, evaluate the wildlife hazards and prepare a WHMP that indicates methods of minimizing the hazards.

5.5.C MITIGATION FOR WETLAND IMPACTS FROM AIRPORT PROJECTS

This water body at a major west coast USA airport should be removed because it provides ideal habitat for waterfowl and wading birds hazardous to aircraft. However, the water has also been designated as critical habitat for the endangered Riverside fairy shrimp. Airports must work closely with multiple federal and state agencies to resolve such conflicts (Photo by T. Pitlik, USDA)

Wetland mitigation might be necessary when wetland disturbances result from new airport development projects or projects required to correct wildlife hazards from wetlands. Wetland mitigation must be designed so it does not create a wildlife hazard. Locate wetland mitigation projects that may attract hazardous wildlife outside of the separations identified in AC 150/5200-33A (see above and Appendix C).

5.5.C.I ON-SITE MITIGATION OF WETLAND FUNCTIONS

The FAA may consider exceptions to locating mitigation activities outside the separations identified in AC 150/5200-33A (see above and Appendix C) if the affected wetlands provide unique ecological functions, such as critical habitat for threatened or endangered species or ground water recharge, which cannot be replicated when moved to a different location. Using existing airport property is sometimes the only feasible way to achieve the mitigation ratios mandated in regulatory orders and settlement agreements with the resource agencies. Conservation easements are an additional means of providing mitigation for project impacts. Typically the airport operator continues to own the property, and an easement is created stipulating that the property will be maintained as habitat for state or federally listed species.

Mitigation must not inhibit the airport operator's ability to effectively control hazardous wildlife on or near the mitigation site or effectively maintain other aspects of safe airport operations. Avoid enhancing such mitigation areas to attract hazardous wildlife. The FAA may review any onsite mitigation proposals to determine compatibility with safe airport operations. In cooperation with a wildlife damage management biologist, evaluate any wetland mitigation projects that are needed to protect unique wetland functions and that must be located in the separation criteria in AC 150/5200-33A (see above and Appendix C) before the mitigation is implemented. Develop a WHMP to reduce any identified wildlife hazards.

5.5.C.II OFF-SITE MITIGATION OF WETLAND FUNCTIONS

Site wetland mitigation projects that might attract hazardous wildlife outside of the separations identified in AC 150/5200-33A (see above and Appendix C) unless they provide unique functions that must remain onsite (see 2-4c(1)). Agencies that regulate impacts to or around wetlands recognize that it might be necessary to split wetland functions in mitigation schemes. Therefore, regulatory agencies may, under certain circumstances, allow portions of mitigation to take place in different locations.

5.5.C.III MITIGATION BANKING

Wetland mitigation banking is the creation or restoration of wetlands in order to provide mitigation credits that can be used to offset permitted wetland losses. Mitigation banking benefits wetland resources by providing advance replacement for permitted wetland losses; consolidating small projects into larger, better-designed and managed units; and encouraging integration of wetland mitigation projects with watershed planning. This last benefit is most helpful for airport projects, as wetland impacts mitigated outside of the separations identified in AC 150/5200-33A (see above and Appendix C) can still be located within the same watershed. Wetland mitigation banks meeting the separation criteria offer an ecologically sound approach to mitigation in these situations. Working with local watershed management agencies or organizations, develop mitigation banking for wetland impacts on airport property. See Appendix M for a more detailed discussion of this issue.

During the first winter following its completion, over 20,000 Bonaparte's gulls used this dredge spoil containment area (far right of photo) constructed next to an airport on Lake Erie's shoreline. The airport's main runway can be seen to the left (photo by E. Cleary, FAA).

5.6 DREDGE SPOIL CONTAINMENT AREAS

Do not locate dredge spoil containment areas (also known as Confined Disposal Facilities) within the separations identified in AC 150/5200-33A (see above and Appendix C) if the containment area has standing water or the spoils contain material that would attract hazardous wildlife.

5.7 AGRICULTURAL ACTIVITY

5.7.A CROP PRODUCTION

Because most, if not all, agricultural crops can attract hazardous wildlife during some phase of production, do not use airport property for crop production, including hay crops, within the separations identified in AC 150/5200-33A (see above and Appendix C).

If the airport has no financial alternative to agricultural crops to produce income necessary to maintain the viability of the airport, then the airport must follow the crop distance guidelines listed in the table titled "Minimum Distances between Certain Airport Features and Any On-Airport Agricultural Crops" found in AC 150/5300-13, *Airport Design,* Appendix 19. Avoid production of cereal grains and sunflowers. Weigh the cost of wildlife control and potential accidents against the income produced by the on-airport crops when deciding whether to allow crops on the airport.

5.7.B LIVESTOCK PRODUCTION

Confined livestock operations (i.e., feedlots, dairy operations, hog or chicken production facilities, or egg-laying operations) often attract flocking birds, such as starlings, that pose a hazard to aviation. Therefore, keep such facilities outside of the separations identified in AC 150/5200-33A (see above and Appendix C). Develop a program to reduce the attractiveness of any livestock operation within these separations. Do not graze free-ranging livestock on airport property because the animals might wander onto the AOA. Livestock feed, water, and manure might attract hazardous birds.

Various fish-eating birds are attracted to aquaculture facilities as demonstrated by these great egrets at a southern USA catfish pond complex. Attempts to repel the birds using propane exploders failed because the birds habituated to the sound (photo by D. LeBlanc, USDA).

5.7.C AQUACULTURE

Aquaculture activities (e.g., catfish, trout, bait fish production) conducted outside of fully enclosed buildings are inherently attractive to a variety of birds. Existing aquaculture facilities/activities within the separations listed in AC 150/5200-33A (see above and Appendix C) must have a program developed to reduce the attractiveness of the sites to species that are hazardous to aviation safety. Oppose the establishment of new aquaculture facilities/activities within the separations listed in AC 150/5200-33A (see above and Appendix C).

5.7.D ALTERNATIVE USES OF AGRICULTURAL LAND

Some airports are surrounded by vast areas of farmed land within the distances specified in AC 150/5200-33A (see above and Appendix C). Seasonal uses of these agricultural lands for activities such as waterfowl hunting can create a hazardous wildlife situation. Rice farmers, for example, might flood their land during waterfowl hunting season and obtain additional revenue by renting out duck blinds. The duck hunters, using decoys and calls, draw in large numbers of birds, creating a threat to aircraft safety. It is recommended that a wildlife damage management biologist review, in coordination with local farmers and airport management, these types of seasonal land uses. Restrictions to seasonal land uses that are incompatible with aviation safety should be incorporated into the WHMP.

5.8 Golf courses, landscaping, and other land-use considerations

5.8.a Golf courses

The large grassy areas and open water found on most golf courses are attractive to hazardous wildlife, particularly Canada geese, mallards, and gulls. These species can pose a threat to aviation safety. Do not site new golf courses within the separations identified in AC 150/5200-33A (see above and Appendix C). Existing golf courses located within these separations must develop a program to reduce the attractiveness of the sites to species that are hazardous to aviation safety. Ensure these golf courses are monitored on a continuing basis for the presence of hazardous wildlife. If hazardous wildlife is detected, take corrective actions immediately.

5.8.b Landscaping and landscape maintenance

Depending on geographic location and plant selection and spacing, airport landscaping can attract hazardous wildlife. Approach landscaping with caution, and confine it to airport areas not associated with aircraft movements. In cooperation with a wildlife damage management biologist, review all landscaping plans. Monitor all landscaped areas on a continuing basis for the presence of hazardous wildlife. If hazardous wildlife is detected, take corrective actions immediately.

Trees and shrubs that produce fruits that are attractive to birds, such as these pyracanthas at a western USA airport, should not be used in landscape designs on airport property. Dense stands of evergreen trees also should be avoided as they provide ideal roosting sites for flocks of starlings and blackbirds (photo by R. A. Dolbeer, USDA).

Turf grass areas can be highly attractive to a variety of hazardous wildlife species. Research conducted by the USDA/WS National Wildlife Research Center has shown that no one grass management regime will deter all species of hazardous wildlife in all situations. In cooperation with a wildlife damage management biologist, develop airport turf grass management plans on a prescription basis, depending on the airport's geographic location and the type of hazardous wildlife likely to frequent the airport. See Chapter 9 and Appendix O for more information on vegetation management.

Ensure that plant varieties attractive to hazardous wildlife are not used on the airport. Do not plant disturbed areas or areas in need of re-vegetating with seed mixtures containing millet or any other large-seed producing grass. Prevent plant maturation and seed head production on airport property already planted with seed mixtures containing millet, rye grass, or other large-seed producing grasses by the use of disking, plowing, or another suitable agricultural practice. Follow the specific recommendations for grass management and seed and plant selection made by the State University Cooperative Extension Service, the local office of USDA/Wildlife Services, or a qualified wildlife damage management biologist. Consider developing and implementing a preferred/prohibited plant species list, reviewed by a wildlife damage management biologist, which has been designed for the geographic location to reduce the attractiveness to hazardous wildlife for landscaping airport property. Avoid installation of ponds, fountains, reflecting pools, and other water bodies as part of an airport's landscaping scheme.

5.8.C OTHER HAZARDOUS WILDLIFE ATTRACTANTS

Other specific land uses or activities (e.g., sport or commercial fishing, shellfish production or harvesting), perhaps unique to certain regions, have the potential to attract hazardous wildlife. Regardless of the source of the attraction, when hazardous wildlife is noted on a public-use airport, airport operators must take prompt remedial action to protect aviation safety.

This open dumpster at a park 0.5 mile from a west coast USA airport served as a strong attractant for gulls, pigeons, and crows. Airports must work with surrounding landowners and local governments to prevent bird attractants near airports (photo by R. A. Dolbeer, USDA).

5.9 SYNERGISTIC EFFECTS OF SURROUNDING LAND USES

There might be circumstances where two (or more) different land uses that would not, by themselves, be considered hazardous wildlife attractants or that are located outside of the separations identified in AC 150/5200-33A (see above and Appendix C) that are in such an alignment with the airport as to create a wildlife corridor directly through the airport and/or surrounding airspace. An example of this situation might involve a lake located outside of the separation criteria on the east side of an airport and a large hayfield on the west side of an airport—land uses that together could create a flyway for Canada geese directly across the airspace of the airport. There are numerous examples of such situations; therefore, airport operators and the wildlife damage management biologist must consider the entire surrounding landscape and community when developing the WHMP.

CHAPTER 6: DEVELOPING WILDLIFE HAZARD MANAGEMENT PROGRAMS AT AIRPORTS

The pilot of this Cessna 172 made a Mayday call to a nearby Air Traffic Control Tower in Texas after hitting a bird (likely a vulture) with the left wing at 800 feet AGL on 8 July 2003. The pilot attempted to make an emergency landing in a field but lost control and crashed, killing him and his passenger (photo courtesy of FAA).

6.1 INTRODUCTION

In recognition of the increased risk of serious aircraft damage or the loss of human life that can result from a wildlife strike, greater emphasis is being placed on preparing airport Wildlife Hazard Management Plans that effectively deal with the problem. This heightened awareness and increased effort has raised many questions about the preparation and content of an FAA-approved Wildlife Hazard Management Plan for an airport. The specific events that trigger a Wildlife Hazard Assessment and the specific issues that a Wildlife Hazard Management Plan must address for FAA approval and inclusion in the airport's Airport Certification Manual (ACM) are described in 14 CFR 139.337 (Appendix P).

It is important to note that regardless of whether a Wildlife Hazard Assessment has ever been required or a Wildlife Hazard Management Plan has been developed, airport operators must be ready to deal with hazardous wildlife on or near the airport. The airport operator must be prepared to take immediate action to deal with unexpected incursions of hazardous wildlife into the AOA, loading ramps, or parking areas (14 CFR 139.337(a)).

14 CFR 139.337	Comments
(a). In accordance with its Airport Certification Manual and the requirements of this section, each certificate holder shall take immediate action to alleviate wildlife hazards whenever they are detected.	Public-use airport operators need to be aware of any hazardous wildlife attractants on or near their airport, even if a wildlife strike has never been reported from the airport. Airport personnel need at least a minimal understanding of wildlife hazard control issues.

The Air Traffic Control (ATC) Tower is a good place to start a Wildlife Hazard Assessment. The tower presents an excellent overview of the airport and provides an opportunity to talk to ATC personnel about wildlife they have seen on the airport (photo by A. Gosser, USDA).

6.2 WILDLIFE HAZARD ASSESSMENT

The first step in preparing an airport Wildlife Hazard Management Plan is to conduct a Wildlife Hazard Assessment. The Wildlife Hazard Assessment, conducted by a wildlife damage management biologist, provides the scientific basis for the development, implementation, and refinement of a Wildlife Hazard Management Plan. Though parts of the Wildlife Hazard Assessment may be incorporated directly into the Wildlife Hazard Management Plan, they are two separate documents.

6.2.A REQUIREMENT FOR WILDLIFE HAZARD ASSESSMENT

Title 14 CFR 139.337(b)(1–4) requires that, in a manner authorized by the Administrator, each certificate holder must ensure that a Wildlife Hazard Assessment is conducted when any of the following events occurs on or near the airport:

1. An air carrier aircraft experiences multiple wildlife strikes;
2. An air carrier aircraft experiences substantial damage from striking wildlife;

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

The following provides a point-by-point comment on the regulations concerning the events that trigger a wildlife hazard assessment.

14 CFR 139.337	Comments
(b) In a manner authorized by the Administrator, each certificate holder shall ensure that a Wildlife Hazard Assessment is conducted when any of the following events occurs on or near the airport.	A wildlife hazard assessment, conducted by a qualified wildlife damage management biologist, must be conducted if—
(b) (1) An air carrier aircraft experiences a multiple wildlife strike	Aircraft strikes more than one animal (geese, starlings, bats, deer, coyotes, etc.).
(b) (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	The definition of substantial damage is taken directly form the International Civil Aviation Organization (ICAO) *Manual on the International Civil Aeronautics Organization Bird Strike Information System.*
(b) (3) An air carrier aircraft experiences an engine ingestion of wildlife; or	Wildlife is ingested into a turboprop, turbofan, or turbojet engine. Engine damage does not have to result from the ingestion.
(b) (4) Wildlife of a size, or in numbers, capable of causing an event described in paragraph (b)(1), (2), or (3) of this section is observed to have access to any airport flight pattern or aircraft movement area.	Airports with a standing Notice to Airmen (NOTAM), announcements on their Automatic Terminal Information Service (ATIS), or comments in Airport/Facility Directory (A/FD) warning pilots of wildlife hazards on or near the airport meet this condition.

6.2.B NECESSARY ELEMENTS OF A WILDLIFE HAZARD ASSESSMENT

Title 14 CFR 139.337 (c)(1–5) provides specific guidance as to what facts must be addressed in a Wildlife Hazard Assessment. The following is a point-by-point comment on each section of the regulations concerning the factors to be addressed in a Wildlife Hazard Assessment.

14 CFR 139.337	Comments
(c) The Wildlife Hazard Assessment … shall be conducted by wildlife damage management biologist … having training or experience in wildlife hazard management at airports … or working under the direct supervision …	The Wildlife Hazard Assessment (WHA) is to be conducted by someone having the following qualifications: Education: Meets U.S. Office of Personal Management standards for GS-486 Wildlife Biologist. Work experience: Has prepared a WHA acceptable to the FAA. Has prepared a Wildlife Hazard Management Plan acceptable to the FAA. Or, is working under the direct supervision of someone who meets the above requirements.
(c) cont. … the Wildlife Hazard Assessment shall contain:	
(c) (1) Analysis of the event or circumstances that prompted the study.	Who, what, when, where, why of the situation prompting the WHA.
(c) (2) Identification of the wildlife species observed and their numbers, locations, local movements, and daily and seasonal occurrences.	What wildlife species have access to the airport? What are their legal status, movement patterns, and seasonal patterns? Refer to Table 7-1 for a ranked listing of hazardous species. Pay particular attention to those species considered the most hazardous occurring on or near the airport.
(c) (3) Identification and location of features on and near the airport that attract wildlife.	Wildlife are attracted to an airport because something exists on or near the airport that they desire, such as large open areas where they can loaf in relative safety; abundant food or water; and escape, loafing, or nesting cover. These attractants need to be identified and evaluated.

14 CFR 139.337	Comments
(c) (4) Description of the wildlife hazards to air carrier operations.	This is a judgment call best made by a professional wildlife management biologist trained in dealing with airport issues. Hitting 3-4 swallows is much less hazardous than hitting one 12-pound Canada goose (see Table 7-1).
(c) (5) Recommended actions for reducing identified wildlife hazards to air carrier operations.	The biologist preparing the WHA must provide prioritized recommendations for mitigating the hazardous wildlife attractants identified in (c)(3).

6.2.C DURATION OF WILDLIFE HAZARD ASSESSMENT AND BASIC SURVEY TECHNIQUES

In conducting a Wildlife Hazard Assessment 14 CFR Part 139.337 (c)(2) requires the "identification of the wildlife species observed and their numbers, locations, local movements, and daily and seasonal occurrences." In most cases, this requirement dictates that a 12-month assessment be conducted so the seasonal patterns of birds and other wildlife using the airport and surrounding area during an annual cycle can be properly documented. Most regions of the USA have dramatic seasonal differences in numbers and species of migratory birds. Even for non-migratory wildlife, such as deer and resident Canada geese, behavior and movement patterns can change significantly among seasons. Observations of wildlife at an airport and surrounding areas limited to a few days in a single season generally cannot adequately assess hazardous wildlife issues and associated habitat attractants.

During the WHA, special attention must be paid to the presence of domestic animals on the airport. This Beachcraft Baron struck an 80-pound dog (chow) during a night departure. The center landing gear collapsed and both propellers struck the ground.

In order to adequately identify "the wildlife species observed and their numbers, locations, local movements, and daily and seasonal occurrences" during a Wildlife Hazard Assessment, the FAA and USDA/WS recommend that standardized survey procedures be used. These standardized procedures should provide an objective assessment of hazardous wildlife in the airport environment that can be repeated in future years for comparative purposes. One objective procedure for assessing bird populations, based on North American Breeding Bird Survey methodology, is the establishment of standardized survey points about ½ mile apart throughout the AOA (10-20 survey points are generally recommended depending on size of airport). Assigning each bird or bird flock observed during a point count to a grid location can be useful in further refining spatial distributions of birds on the airport. Additional survey points may be established in nearby off-airport areas (e.g., taxicab lot, golf course, or city park) suspected of attracting hazardous birds that move across the AOA. Standardized counts of birds should be made at each of these survey points at least twice monthly. In addition, specialized surveys might be needed as part of the overall assessment to document large-to-mid-sized mammals, such as deer or jackrabbits (from vehicle using spotlight or night vision equipment), and small mammals, such as voles and mice (snap traps), on the airport. These specialized mammal surveys should be conducted at least twice during a 12-month WHA.

Bodies of open water adjacent to airports, such as this drainage canal, are often magnets for waterfowl and wading birds. Note the shallow slope that allows birds easy access in and out of the water. Such canals should be covered if possible or diverted away from the airport (photo by E. Cleary, FAA).

6.3 Wildlife Hazard Management Plan

6.3.a Requirement for Wildlife Hazard Management Plan

When complete, the Wildlife Hazard Assessment is submitted to the FAA for evaluation and determination whether a Wildlife Hazard Management Plan needs to be developed for the airport. In reaching this decision, the FAA will consider the Wildlife Hazard Assessment, the aeronautical activity at the airport, the views of the certificate holder and airport users, and any other pertinent information (14 CFR 139.337 (d)(1–6)). At a minimum, it is recommended that the airport manager develop and implement a plan to deal with any hazardous wildlife attractants or situations identified in the Wildlife Hazard Assessment.

If the FAA determines that a Wildlife Hazard Management Plan is needed, the airport operator must then formulate and implement a Wildlife Hazard Management Plan, using the Wildlife Hazard Assessment as the basis for the plan (14 CFR 139.337 (e)(1–3)). At the same time, the FAA regional coordinator will contact the local U.S. Fish and Wildlife Service (USFWS), Ecological Services Field Office and request information about the presence of federally listed or proposed endangered or threatened species or designated or proposed critical habitat on or near the airport. (See FAA Airport Certification Program, Program Policy and Guidance No. 78, Section-7 Consultation on Endangered or Threatened Species, Appendix D.) The USFWS response will be forwarded to the airport operator to be taken into account when preparing the required plan.

If federally listed or proposed endangered or threatened species or designated or proposed critical habitat are present, the airport operator must prepare a Biological Assessment (50 CFR 402.13) assessing the impacts of the Wildlife Hazard Management Plan on these species or habitats. The Biological Assessment and draft Wildlife Hazard Management Plan must be submitted to the FAA for review and approval.

Airport management may request the wildlife biologist who prepared the Wildlife Hazard Assessment to assist with the preparation of the Wildlife Hazard Management Plan and to review the finished plan. However, only the airport operator can commit airport resources (time, money, personal), and the ultimate responsibility for the development and implementation of the plan rests with the airport operator. When the plan is completed the airport operator must submit the draft plan, together with a copy of the Biological Assessment, to the FAA for approval. The FAA will conduct any needed Section 7 consultations with the USFWS.

The presence of a threatened or endangered species on an airport, such as this nesting California least tern, would constitute extraordinary circumstances and require preparation of either an Environmental Assessment or an Environmental Impact Statement before the Wildlife Hazard Management Plan could receive FAA approval (photo courtesy of USFWS, NTCT Image Library).

6.3.B. NATIONAL ENVIRONMENTAL POLICY ACT REVIEW

The FAA's approval of a draft Wildlife Hazard Management Plan is covered by the categorical exclusion in FAA Order 1050.1E, paragraph 308e. Before the FAA approves a draft Wildlife Hazard Management Plan, the FAA must determine whether or not the draft Wildlife Hazard Management Plan involves extraordinary circumstances (see FAA Order 1050.1E, paragraphs 303c and 304).

- If a draft Wildlife Hazard Management Plan does not involve extraordinary circumstances, the FAA may categorically exclude the Wildlife Hazard Management Plan under FAA Order 1050.1E, paragraph 308e.
- If a draft Wildlife Hazard Management Plan involves extraordinary circumstances, the FAA may require the airport sponsor to prepare an EA, or the FAA may prepare an EIS.

Once a draft Wildlife Hazard Management Plan is approved, the plan is returned to the airport sponsor for inclusion in the airport's Airport Certification Manual and is enforceable.

6.3.C Necessary elements of a Wildlife Hazard Management Plan

The goal of an airport's Wildlife Hazard Management Plan is to minimize the risk to aviation safety, airport structures or equipment, or human health posed by populations of hazardous wildlife on and around the airport.

As part of the Wildlife Hazard Management Plan, pilots should be reminded to conduct a pre-flight inspection of their aircraft for bird nesting material, especially if the aircraft is parked outside or has not been used for some time (photo courtesy USDA).

The Wildlife Hazard Management Plan must accomplish the following:

- Identify personal responsible for implementing each phase of the plan,
- Identify and provide information on hazardous wildlife attractants on or near the airport,
- Identify appropriate wildlife management techniques to minimize the wildlife hazard,
- Prioritize appropriate management measures,
- Recommend necessary equipment and supplies,
- Identify training requirements for the airport personnel who will implement the Wildlife Hazard Management Plan, and
- Identify when and how the plan will be reviewed and updated.

It is often helpful for the airport manager to appoint a Wildlife Hazards Working Group that periodically reviews the airport's Wildlife Hazard Management Plan and the plan's implementation to make recommendations for further refinements or modifications (see Chapter 7).

14 CFR 139.337 (f)(1–7) provides specific guidance as to what facts must be addressed in a Wildlife Hazard Management Plan. The following table details how the requirements of Part 139.337 (f) (1–7) are to be addressed in an FAA-approved Wildlife Hazard Management Plan (see also Appendix E).

14 CFR 139.337	Comments
(f). The Wildlife Hazard Management Plan shall include at least the following :	
(f) (1) A list of the individuals having authority and responsibility for implementing each aspect of the plan.	Assign or delegate specific responsibilities for various sections of the Wildlife Hazard Management Plan to various airport departments, such as— • Airport Director • Operations Dept. • Maintenance Dept. • Security Dept. • Planning Dept. • Finance Dept. • Wildlife Coordinator • Wildlife Hazards Working Group • Local law enforcement authorities that might provide wildlife law enforcement and other support include — o U.S. Fish and Wildlife Service o State Wildlife Agency o City Police o County Sheriff

14 CFR 139.337	Comments
(f) (2) A list prioritizing the following actions identified in the wildlife hazard assessment and target dates for their initiation and completion:	Provide a prioritized list of problem wildlife populations and wildlife attractants (food, cover, and water) identified in the WHA, proposed mitigation actions, and target starting and completion dates. A list of completed wildlife population management projects and habitat modification projects designed to reduce the wildlife strike potential can be included to provide a history of work already accomplished. It is helpful to group attractants by areas and ownership. Airport property: • Air Operations Area (AOA) • Within 2 miles of AOA • Airport structures Non-airport property • Within 2 miles of AOA • Within 5 miles of AOA
(f) (2) (i) Wildlife population management;	Address species-specific population management plans (e.g., deer, gulls, geese, and coyotes): • Habitat modification • Resource protection • Repelling/exclusion • Removal Chapter 9 provides a discussion of the various wildlife control methods.

14 CFR 139.337	Comments
(f) (2) (ii) Habitat modification; and	Food/prey management: • Rodents • Earthworms • Insects • Grain/seeds • Garbage—handling, storage • Handouts (feeding wildlife) Vegetation management: • AOA vegetation • Drainage ditch vegetation • Landscaping • Agriculture Water management: • Permanent Water • Wetlands • Canals/ditches/streams • Holding ponds • Sewage (glycol) treatment ponds • Other water areas • Ephemeral water o Runways, taxiways, aprons o Other wet areas Airport buildings: • Airfield structures • Abandoned structures • Terminal • Airport construction

14 CFR 139.337	Comments
(f) (2) (ii) [cont.] [and] land use changes.	i.e., Elimination of agricultural activities on or near the airport, surface mining, urban development, creation of off-airport storm water management systems.

(f) (3) Requirements for and, where applicable, copies of local, state, and federal wildlife control permits.	Certain species of wildlife might be protected at all levels of government—local, state, and federal—or might not be protected at all, depending on location and species. Address the specific species involved and their legal status in this section. Describe the wildlife management permitting requirements and procedures for all levels of government having jurisdiction, i.e.—
	• Federal – 50 CFR, Parts 1 to 199.
	• State – Fish and Game Code (or equivalent)
	• City, county – ordinances
	• If pesticides are to be used, the following are also needed:
	  o Pesticide-use regulations:
	  o Federal: Federal Insecticide, Fungicide, and Rodenticide Act.
	  o State (varies by state)
	  o Pesticide-use licensing requirements
	  o State regulations
	Summaries are generally adequate. It is not necessary to quote chapter and verse of federal, state, and local laws and regulations.

14 CFR 139.337	Comments
(f) (4) Identification of resources that the certificate holder will provide to implement the plan.	Provide information identifying what resources the airport will supply in terms of— • Personal • Time • Equipment (e.g., radios, vehicles, guns, traps, propane cannons, etc.) • Supplies (e.g., pyrotechnics) • Pesticides (restricted/non-restricted use) • Application equipment • Sources of supply for equipment and supplies
(f) (5) Procedures to be followed during air carrier operations that at a minimum includes—	
(f) (5) (i) Designation of personnel responsible for implementing the procedures;	Who, when, what circumstances: • Wildlife Control Personnel • Wildlife Coordinator • Operations Dept. • Maintenance Dept. • Security Dept. • Air Traffic Control
(f) (5) (ii) Provisions to conduct physical inspections of the aircraft movement areas and other areas critical to successfully manage known wildlife hazards before air carrier operations begin;	Who, when, how, what circumstances: • Runway, taxiway sweeps • AOA monitoring • Other areas attractive to wildlife

14 CFR 139.337	Comments
(f) (5) (iii) Wildlife hazard control measures; and	Who, what circumstances, when, and how are Wildlife Control Personnel contacted? What methods are to be used to— • Repel • Capture • Kill
(f) (5) (iv) Ways to communicate effectively between personnel conducting wildlife control or observing wildlife hazards and the air traffic control tower.	Training in communication procedures Equipment needed Radios, cellular phones, lights
(f) (6) Procedures to review and evaluate the wildlife hazard management plan annually or following an event described in paragraphs (b)(1), (2), and (3) of this section, including:	At a minimum, hold annual meetings, or meet after an event described in 139.337(a)(1–3) with representatives from all airport departments involved in wildlife hazard management efforts and the wildlife damage management biologist who did the original Wildlife Hazard Assessment.
(f) (6) (i) The plans effectiveness in dealing with known wildlife hazards on and in the airport's vicinity and:	Input from all airport departments, Air Traffic Control, and the wildlife biologist as to effectiveness of the plan. Good records are required for evaluating the effectiveness of a program (see Chapter 7).
(f) (6) (ii) Aspects of the wildlife hazards described in the wildlife hazard assessment that should be reevaluated.	For example— • Number of times wildlife seen on AOA. • Requests for wildlife dispersal from air traffic control, pilots, or others. • Increased number of strikes.

14 CFR 139.337	Comments
(f) (7) A training program conducted by a qualified wildlife damage management biologist to provide airport personnel with the knowledge and skills needed to successfully carry out the wildlife hazard management plan required by paragraph (d) of this section.	Training for— • Wildlife control personnel • Other airport personnel • Pesticide user training and certification (See Chapter 8)
(g) FAA Advisory Circulars contain methods and procedures for wildlife hazard management at airports that are acceptable to the Administrator.	AC 150/5200-33A, *Hazardous Wildlife Attractants on or Near Airports*

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Table 6-1. Airport Wildlife Hazard Review Worksheet. Page 1 of 5

Airport Name (LOCID)			
City: State: FAA Region:			
Wildlife Hazard Assessment Evaluation			
Elements	Reference 14 CFR 139.337	Complete	Comments
The wildlife hazard assessment … shall contain at least the following:	(c)		
Analysis of event(s) or circumstances that prompted the assessment.	(c) (1)		
Identification of the wildlife species observed, and … .	(c) (2)		
description of species numbers,	(c) (2)		
description of species local movements,	(c) (2)		
description of daily occurrences,	(c) (2)		
description of seasonal occurrences.	(c) (2)		
Identification and location of features on and near the airport that attract wildlife.	(c) (3)		
Description of wildlife hazard to air carries operations.	(c) (4)		
Recommendations for mitigation of identified wildlife attractants.	(c) (5)		

Table 6-1. Airport Wildlife Hazard Review Worksheet. Page 2 of 5

Airport Name (LOCID)			
City: State: FAA Region:			
Determination of Need for Wildlife Hazard Management Plan			
Elements	Reference 14 CFR 139.337	Complete	Comments
Review of Wildlife Hazard Assessment.	(d)		
Wildlife Hazard Assessment.	(d) (1)		
Actions recommended in WHA.	(d) (2)		
Aeronautical activity.	(d) (3)		
Certificate holder's views.	(d) (4)		
Airport users' views.	(d) (5)		
Other factors.	(d) (6)		
Development of Wildlife Hazard Management Plan to be required by FAA.	Yes	No	
Endangered Species Act, Section 7 consultation needed.	Yes	No	
Letter sent to USFWS.	Yes	No	Date sent
USFWS response received.	Yes	No	Date received
USFWS response forwarded to airport sponsor, if positive.	Yes	No	Date sent
FAA Official making this determination:	Signature		Date

Table 6-1. Airport Wildlife Hazard Review Worksheet. Page 3 of 5

Airport Name (LOCID)			
City:	State:	FAA Region:	
Wildlife Hazard Management Plan Evaluation			
Elements	Reference 14 CFR 139.337	Complete	Comments
The plan shall include at least the following:	(f)		
A list of the individuals having authority and responsibility for implementing each aspect of the plan (Airport and non-airport personnel).	(f) (1)		
A list prioritizing the following actions identified in the wildlife hazard assessment and, target dates for their initiation and completion:	(f) (2)		
Wildlife population management;	(f) (2) (i)		
Habitat modification; and	(f) (2) (ii)		
Land-use changes.	(f) (2) (iii)		
Requirements for and, where applicable, copies of local, state, and federal wildlife control permits (Including pesticide use, where applicable).	(f) (3)		
Identification of resources that the certificate holder will provide to implement the plan.	(f) (4)		
Procedures to be followed during air carrier operations that at a minimum includes:	(f) (5)		

Table 6-1. Airport Wildlife Hazard Review Worksheet. Page 4 of 5

Airport Name (LOCID)			
City: State: FAA Region:			
Wildlife Hazard Management Plan Evaluation (Continued)			
Elements	Reference 14 CFR 139.337	Complete	Comments
Designation of personnel responsible for implementing the procedures;	(f) (5) (i)		
Provisions to conduct physical inspections of the aircraft movement areas and other areas critical to successfully manage known wildlife hazards before air carrier operations begin;	(f) (5) (ii)		
Wildlife hazard control measures; and	(f) (5) (iii)		
Ways to communicate effectively between personnel conducting wildlife control or observing wildlife hazards and the air traffic control tower.	(f) (5) (iv)		
Procedures to review and evaluate the wildlife hazard management plan annually or following an event described in paragraphs (b)(1), (2), and (3) of this section, including:	(f) (6)		
The plans effectiveness in dealing with known wildlife hazards on and in the airport’s vicinity and:	(f) (6) (1)		

Table 6-1. Airport Wildlife Hazard Review Worksheet. Page 5 of 5

Airport Name (LOCID)			
City:	State:	FAA Region:	
Wildlife Hazard Management Plan Evaluation (Continued)			
Elements	Reference 14 CFR 139.337	Complete	Comments
Aspects of the wildlife hazards described in the wildlife hazard assessment that should be reevaluated.	(f) (6) (ii)		
A training program conducted by a qualified wildlife damage management biologist to provide airport personnel with the knowledge and skills needed to successfully carry out the wildlife hazard management plan required by paragraph (d) of this section.	(f) (7)		
FAA Advisory Circulars contain methods and procedures for wildlife hazard management at airports that are acceptable to the Administrator.	(g)		
Section 7 Consultation completed with USFWS.	Yes	No	Date completed
NEPA coordination.	Yes	No	
Categorical exclusion.	Yes	No	
EA/EIS required.	Yes	No	
Wildlife Hazard Management Plan approved by:	Signature		Date

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CHAPTER 7:
EVALUATING WILDLIFE HAZARD MANAGEMENT PROGRAMS AT AIRPORTS

This engine suffered major damage after ingesting a large bird on departure from a midwestern USA airport. A UV emitting "black light" flashlight can be useful in detecting organic remains from birds in the engine.

7.1 INTRODUCTION

Wildlife populations on and in the vicinity of airports are constantly changing in response to changes in land use, state and federal management policies, and environmental factors. In addition, wildlife might adapt or habituate to control strategies that were once effective, or they might develop new behavioral or feeding patterns on or near the airport. New wildlife control technologies might become available, or established products or techniques might be withdrawn or banned. Finally, there might be changes in wildlife control and management personnel at an airport. Once a Wildlife Hazard Management Plan is in place, develop a process to evaluate the plan at least annually.

Update the plan as needed, based on the annual evaluation (14 CFR 139.337 [f][6]). This chapter outlines a means of conducting such evaluations.

7.2 MONITORING AND RECORD KEEPING

The importance of accurate monitoring and record keeping cannot be overemphasized. Without consistently maintained records of wildlife activity, wildlife strikes, and wildlife management actions, the proper evaluation of a program is impossible. Without evaluation, no assessment of the effectiveness of a program can be made. Furthermore, without accurate records and proper evaluation, it might be difficult to justify and defend certain management actions, such as wildlife removal, or to defend the airport during litigation in the aftermath of a damaging wildlife strike (see Appendix N).

7.2.A HAZARD ASSESSMENTS, PLANS, AND STUDIES

As discussed in Chapter 8, to facilitate access and reduce losses, keep all reference books, such as wildlife field guides, videos, posters, and other training and educational materials, in a specific location. For ready reference, have copies of Wildlife Hazard Assessments, Wildlife Hazard Management Plans, and other relevant wildlife studies conducted at the airport available at this site. Ideally, locate the wildlife library at the site where information on wildlife control activities and wildlife strikes is entered into logs, files, and databases.

Sweep nets can be used to monitor and identify insect populations, such as Japanese beetles, that attract gulls and other birds to an airport so pesticide applications and other control strategies can be implemented in a timely manner (photos by T. W. Seamans, USDA).

7.2.B DAILY LOG OF WILDLIFE CONTROL ACTIVITIES

Maintain a daily log of wildlife activity and management actions; important factors to record include—

- Date, time, and location on airport where wildlife is observed.
- Species of wildlife and approximate numbers.

- Control actions taken and response of wildlife.

Record this information on a standard form (see Table 7-1 for an example of a daily log form) that can be used by wildlife control personnel at the site where the activity takes place. If a form is not available, record the information in a log book kept at the operations base.

The use of a standardized form or recording format, such as that presented in Table 7-1, is strongly recommended. The information recorded will be most useful if it is summarized into monthly and annual statistics (see below). Use of a standardized format allows this summarization to be easily done. The use of computerized database systems customized to provide summaries of wildlife control activities is recommended.

7.2.C DAILY LOG OF WILDLIFE STRIKES

Maintaining a consistent record of wildlife strikes is essential for defining the wildlife hazard level for an airport and for evaluating the airport's Wildlife Hazard Management Plan. In addition to maintaining these strike records for internal use at the airport, surface-mail (using FAA Form 5200-7) or electronically submit strike reports to the FAA (http://wildlife.mitigation.tc.faa.gov). The FAA will incorporate the information into the National Wildlife Strike Database (Chapter 2).

This Saab 340 hit a deer on landing at a Midwest USA airport in April 2000, ripping the engine from its mountings (photo courtesy Northwest Airlines).

As defined in the glossary, a wildlife strike has occurred when—

1. A pilot reports striking one or more birds or other wildlife;
2. Aircraft maintenance personnel identify aircraft damage as having been caused by a wildlife strike;
3. Personnel on the ground report seeing an aircraft strike one or more birds or other wildlife;
4. Bird or other wildlife remains are found within 200 feet of the centerline of a runway, unless another reason for the animal's death is identified;
5. The animal's presence on the airport had a significant negative effect on a flight (e.g., aborted takeoff or landing, high-speed emergency stop, aircraft left pavement area to avoid collision with animal).

Top Left. Bird strike remains on an aircraft. **Top Right.** Strike remains being collected. (Smithsonian feather identification specialists refer to the collected material as “snarge.”) **Lower Left.** Smithsonian feather identification specialist preparing snarge to identify the bird. **Lower Right.** Micrograph of a downy feather recovered from the snarge. The feather belongs to a mallard (photos by: Top – M. Begier, USDA; Bottom – C. Dove, Smithsonian Institution).

Record each strike event under categories 1-3 or 5 (reported strike) on FAA Form 5200-7 (Appendix I) and mail (the form is pre-addressed and franked on the back side) or transmit electronically to the FAA. Send photocopies of the form that do not have the address and frank on the back to—

Federal Aviation Administration
Office of Airport Safety and Standards, AAS-310
800 Independence Avenue, SW
Washington, DC 20591

Copies of this form (with the address and frank) can be downloaded and printed from http://wildlife-mitigation.tc.faa.gov. The form also can be filled out and filed electronically at this site.

When filling out Form 5200-7, include as much of the information requested as is available. Typically, not all information requested on the form will be available or known, but the report is valuable even if some information is missing.

For category 4 strikes (wildlife remains found but no report of strike), a log of these incidents should be maintained with the date, location, number, and species of animals struck recorded (Table 7-2). A copy of this log should also be mailed monthly to the FAA at the above address, or these strikes should be reported individually on FAA Form 5200-7 with a notation that a carcass was found but no strike was reported.

For all strike reports, make every effort to have the wildlife correctly identified to species. Freeze specimens that cannot be readily identified in a labeled bag until a local wildlife expert can be consulted. If only feather remains are available, mail them to the Smithsonian Institution Feather Lab for identification (see instructions and address in Chapter 2, and in Advisory Circular 150/5200-32A *Reporting Wildlife Aircraft Strikes*, Appendix C). There is no charge for this identification service. Please include a copy of the strike report or other relevant information with the bird remains to assist the feather experts in identifying the bird.

One approach to controlling rodent populations at airports is the periodic treatment of grass areas with zinc phosphide-treated bait. The application must be under the supervision of a person certified in vertebrate pest control (Photo by R. A. Dolbeer, USDA).

7.2.D RECORDS OF SIGNIFICANT MANAGEMENT ACTIONS TAKEN

In addition to maintaining a daily log of wildlife control activities and wildlife strikes, it is important to keep records of other preventative management actions that might not be part of the daily routine of wildlife control. Examples of such actions might be installing or repairing fencing, thinning trees, clearing construction debris, applying pesticides or repellents, conducting grass-height management, installing netting in hangers or wires over ponds, and regrading pavement or grass areas to eliminate standing water. In addition, activities such as writing letters to catering services about proper storage of food waste are also important management actions. Documenting these activities in some type of summary file or table can aid in determining the total cost and effectiveness of the wildlife control program.

7.2.E SUMMARY REPORTS BY MONTH AND YEAR

Periodically summarize information from the Daily Wildlife Control Activities log and from wildlife strikes records to provide baseline data for analyzing and evaluating the wildlife control program. A logical approach is to conduct monthly summaries that are then incorporated into an annual report. These summaries do not need to be complex but must reflect the level of activity for the common control techniques deployed. For example, monthly summaries of pyrotechnics fired, runway sweeps to clear birds, distress call deployments, birds and mammals removed by species, and wildlife strikes by species would be useful (Table 7-3). Prepare a short paragraph outlining other significant activities during the month, such as repairing a fence, meetings with airport tenants about wildlife issues (e.g., feeding birds in taxi stand area), or regrading an area to remove standing water. Prepare an annual report (Table 7-4) by combining data from the monthly reports. It is emphasized that Tables 7-3 and 7-4 are only presented as examples to provide guidance in developing a format to summarize data. A particular airport might use methods not listed in Tables 7-3 and 7-4, such as falconry, radio-controlled model airplanes, dogs, or propane cannons. The important point is that there must be an objective, numerical documentation of wildlife control methods deployed and wildlife strikes occurring on the airport. The use of a computer database program can be extremely helpful in producing these summary reports.

All airport management, as well as airport operations and maintenance personnel, need a basic understanding of wildlife aircraft strike issues on their airport. Specialized courses in managing wildlife hazards at airports, taught by recognized experts, provide a practical way of doing this. The FAA and USDA/WS can provide this type of training (photo by C. Steves, FAA).

7.2.F TRAINING

Maintain and annually summarize a record of all training that wildlife control personnel have received. Include attendance at conferences, courses and workshops (e.g., firearms safety), self-study courses, and specialized on-the-job training.

7.3 ASSESSMENT OF WILDLIFE HAZARD MANAGEMENT PLAN

All FAA approved Wildlife Hazard Management Plans must be reviewed at least annually or following an event that would normally trigger a Wildlife Hazard Assessment (see 14 CFR 139.337 (b)(1-4) and 139.337 (f)(6)). The review must include: the plan's effectiveness in dealing with known wildlife hazards on and in the vicinity of the airport, and aspects of the wildlife hazards described in the Wildlife Hazard Assessment that should be reevaluated (14 CFR 139.337 (f)(6)). The wildlife damage management biologist that helped prepare the plan and a sub-group from the Airport's Wildlife Hazard Working Group should conduct this review.

Appendix K describes a simple system (modified from Seubert 1994) for assessing a Wildlife Hazard Management Plan at an airport. Five assessment categories are used to indicate the adequacy of a Wildlife Hazard Management Plan and how well the plan is being implemented:

Category 1. Management functions related to wildlife hazards on or in the vicinity of the airport.

Category 2. Bird control on or in the vicinity of the airport.

Category 3. Mammal control on or in the vicinity of the airport.

Category 4. Management of habitat and food sources on airport property related to wildlife hazards.

Category 5. Land uses and food sources off of the airport potentially related to wildlife hazards on airport.

Within Categories 1-4 (activities on the airport), a series of elements are listed that are evaluated as either "Satisfactory", "Unsatisfactory", "Needs Improvement", or "Not Applicable". For Category 5 (off-airport attractants), the elements are scored on a scale of 0 (not present) to 3 (site creates significant wildlife hazard for airport; action should be taken). Those elements deemed "Unsatisfactory" or "Needs Improvement" (in Categories 1-4) or that are scored 2 or 3 (in Category 5) are then commented on in a summary form. The elements listed within each category are not intended to cover every possibility at every airport. The elements can be modified or expanded to meet situations unique to an airport.

Wetlands on airport provide both habitat and food for wildlife. Such areas can be eliminated through wetland mitigation programs (photo by E. Cleary, FAA).

7.4 AIRPORT WILDLIFE HAZARDS WORKING GROUP

7.4.A FUNCTION

Wildlife hazard management on an airport often requires communication, cooperation, and coordination among various groups on the airport and with various local, state, and federal agencies and private entities. For many airports, the establishment of a Wildlife Hazards Working Group (WHWG) will greatly facilitate this communication, cooperation, and coordination.

7.4.B MEMBERSHIP

Include a representative from each of the key groups and agencies that have a significant involvement or interest in wildlife issues on the airport in the WHWG. Airport groups might include representatives from security, maintenance, operations, and air traffic control. From government, representatives from the state wildlife agency, the U.S. Fish and Wildlife Service and USDA/WS might be appropriate. Include representatives from any facility near the airport that significantly attracts wildlife (such as a landfill or wildlife refuge).

In general, do not exceed 10 people in the core WHWG. This will keep meetings from becoming unwieldy. In addition to regular members, invite people with specialized knowledge, interest, or concerns to the meetings as appropriate. Typically, someone from airport management chairs the WHWG. The chair can be rotated among various airport departments.

Airports should establish a Wildlife Hazards Working Group (WHWG) that meets at least annually to facilitate communication, cooperation, and coordination among the various agencies and airport departments. The WHWG also provides a forum to review and update the airport's Wildlife Hazard Management Plan (photo by R. A. Dolbeer, USDA).

7.4.C MEETINGS

At least annually hold a meeting of the WHWG to conduct a general review of the overall wildlife hazard management program for the airport and to discuss special issues or problems as needed. Include the following in the general discussion:

- Strike trends and significant strike events (based on data summarized using formats in Tables 7-3 and 7-4).
- Source of wildlife causing strike problems.
- Wildlife control activities (based on data and commentary summarized using formats in Tables 7-3 and 7-4.
- Wildlife Hazard Management Plan evaluation (based on most recent assessment using format in Appendix K).

Special issues to be discussed might include projected impacts of land-use changes on or near the airport, trends in populations or behavior of various species of wildlife, wildlife removal permits, evaluation of new wildlife control technologies, and clarification of roles and responsibilities. A good way to end the meeting might be with a field demonstration of a wildlife management activity on the airport or a site visit to a nearby wildlife attractant (e.g., sewage treatment facility) that might need addressing.

Special meetings of the entire WHWG or a subgroup might be needed after significant strike events or other developments affecting wildlife hazards if a regular meeting is not scheduled for the near future.

7.4.D MEETING REPORTS

Make arrangements to have minutes taken and a summary report written for each meeting. Include in the report a list of attendees, decisions made by the group, deadlines and responsible parties for task assignments, and a list of critical issues that were not resolved.

7.5 SUMMARY AND CONCLUSIONS

Periodic evaluations of an airport's Wildlife Hazard Management Plan and the activities undertaken to implement the plan are critical because of the dynamic nature of wildlife hazards and control technologies. The foundation for these evaluations is the maintenance of consistent records of wildlife control activities and wildlife strikes. The use of standardized formats for keeping these records, such as those presented in Tables 7-1 to 7-4, permits easy compilation of events and activities into monthly and annual statistical and narrative summaries. Once these summaries are available, objective examinations and comparisons can be made of trends in strikes, wildlife activities, control methods deployed, and other factors.

All wildlife carcasses found during aircraft movement area inspections should be removed immediately. Unless another reason for the animal's death can be determined, the incident should be reported as a wildlife strike and recorded in the airport's wildlife strike database (photo courtesy USDA).

An objective, standardized format for assessing a Wildlife Hazard Management Plan and its implementation is presented in Appendix K. This format allows an outside biologist or evaluation group to systematically review the actions being taken and make recommendations in areas where improvement is needed. The availability of summary statistics, such as provided through records maintained in Tables 7-1 to 7-4, is essential for this assessment.

Finally, the establishment of a WHWG provides an excellent means of improving communication, coordination, and cooperation among the diverse groups involved in wildlife hazard management on an airport. The WHWG also can provide an important forum for reviewing, evaluating, and improving an airport's wildlife hazard management program.

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Table 7-1. Example of a daily log of wildlife control activities.

Airport					Month		Year
		Location (Grid)	Wildlife		Control method	Results/comments	Initials
Date	Time		Species	No.			

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Table 7-2. Example of a Wildlife Strike Log for recording bird or other wildlife remains found within 200 feet of runway centerline that, in the judgment of wildlife control personnel, were killed as a result of interacting with an aircraft.

Airport				Month		Year
Date	Time found	Species	Runway	Location on runway	Was strike reported[1]?	Comments

[1]If strike was reported, complete FAA Form 5200-7.

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Table 7-3. Example of a form to provide monthly summary of wildlife control activities.

Airport			Month	Year
Control activity (modify list as appropriate)	This month	Same month last year	Comments (list wildlife dispersed or removed by species and method)	
No. of pyrotechnics fired				
No. of times distress calls deployed				
No. of runway sweeps to clear birds				
No. of wildlife removed				
Miles driven by wildlife patrol				
No. of reported strikes				
No. of reported strikes with damage				
No. of carcasses found (no strike reported)				

Summary paragraph of other wildlife control activities:

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Table 7-4. Example of a form to provide annual summary of wildlife control activities derived from monthly reports (Table 7-3). Modify each airport's form to reflect the common control activities undertaken during the year. The data may also be presented graphically.

Airport				Year					
Number of:									
Month	Pyro-technics fired	Times distress calls deployed	Runway sweeps to clear birds	Wildlife dispersed	Wildlife removed[1]	Miles driven by wildlife patrol	Reported strikes[2]	Reported strikes with damage	Carcasses found (no strike reported)[2]
Jan									
Feb									
Mar									
Apr									
May									
Jun									
Jul									
Aug									
Sep									
Oct									
Nov									
Dec									
Total									

[1]Provide separate list by species and method.

[2]Provide separate list by species.

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CHAPTER 8: WILDLIFE HAZARD MANAGEMENT TRAINING FOR AIRPORT PERSONNEL

Populations of most bird species weighing over 4 pounds have increased dramatically in the USA since 1980. These large birds can cause substantial damage when struck by aircraft (photo courtesy USAF).

8.1 INTRODUCTION

The management of wildlife is a complex endeavor that often attracts public interest. Once an assessment of hazards has been completed and a Wildlife Hazard Management Plan has been developed, the plan must be implemented by well-trained and knowledgeable individuals if it is to be successful in reducing wildlife strikes and accepted by the public.

Depending on the size of an airport and the level of wildlife hazard, the Wildlife Hazard Management Plan may be implemented by a single airport employee undertaking wildlife control activities on an occasional "as needed" basis or by a full-time wildlife biologist with a staff of operations personnel providing continuous bird patrols.

Some of the personnel involved in these control activities, hereafter referred to as wildlife control personnel (WCP), might not have formal education in wildlife biology. All WCP must have sufficient training to be knowledgeable in the basic principles of wildlife management and in the identification, behavior, general life history, and legal status of the hazardous species in the area. WCP also must be trained in the proper implementation or deployment of various control strategies and techniques outlined in the Wildlife Hazard Management Plan. Finally, an awareness of endangered and threatened wildlife species that might visit or reside on the airport is critical.

Training, provided by recognized experts, should include classroom instruction, fieldwork, and attendance at conferences, such as Bird Strike Committee USA/Canada (photo by C. Steves, FAA).

8.2 TRAINING

The following areas of training and levels of skill are suggested for WCP implementing control activities on airports under a Wildlife Hazard Management Plan. It is emphasized that, once a plan is in place, in addition to the training provided to WCP, there must be periodic oversight and review of the plan and its implementation by a professional biologist trained in wildlife damage control (14 CFR 139.337 (f)(7)).

8.2.A BIRD IDENTIFICATION

There are over 600 species of birds that reside in or migrate through the USA. Many of these species, such as gulls, have quite different plumage patterns and bill colors as subadults (year of hatching up to 3 years in some species) than as adults (as an example, see Appendix J for a fact sheet on North American gulls). Some birds, such as laughing gulls, European starlings, and black-bellied plovers, have different summer and winter plumage patterns and bill colors. In other species, such as northern harriers and red-winged blackbirds, males and females appear quite different. Some species are present in an area all year, others only in migration (spring, fall), and others only in winter or in summer. All species have unique vocalizations, behaviors, and habitat preferences that are useful in field identification. Thus, to become an expert in field identification of all bird species at a location requires many years of training and practice. WCP require basic training so they can identify, in all plumages, commonly seen hazardous birds, as well as those rarer species that are considered hazardous when present or are of concern because of endangered- or threatened-species status. Table 8-1 provides a list of the relative hazard of various species groups based on the percent of reported strikes that cause damage or an effect-on-flight.

Table 8-1. Ranking of 25 species groups as to relative hazard to aircraft (1=most hazardous) based on three criteria (damage, major damage, and effect-on-flight), a composite ranking based on all three rankings, and a relative hazard score. Data were derived from the FAA National Wildlife Strike Database, January 1990–April 2003[1].

Species group	Ranking by criteria			Composite ranking[5]	Relative hazard score[6]
	Damage[2]	Major damage[3]	Effect on flight[4]		
Deer	1	1	1	1	100
Vultures	2	2	2	2	64
Geese	3	3	6	3	55
Cormorants/pelicans	4	5	3	4	54
Cranes	7	6	4	5	47
Eagles	6	9	8	6	41
Ducks	5	8	10	7	39
Osprey	8	4	8	8	39
Turkey/pheasants	9	7	11	9	33
Herons	11	14	9	10	27
Hawks (buteos)	10	12	12	11	25
Gulls	12	11	13	12	24
Rock pigeon	13	10	14	13	23
Owls	14	13	20	14	23
Horned lark/snow bunting	18	15	15	15	17
Crows/ravens	15	16	16	16	16
Coyote	16	19	5	17	14
Mourning dove	17	17	17	18	14
Shorebirds	19	21	18	19	10
Blackbirds/starling	20	22	19	20	10
American kestrel	21	18	21	21	9
Meadowlarks	22	20	22	22	7
Swallows	24	23	24	23	4
Sparrows	25	24	23	24	4
Nighthawks	23	25	25	25	1

[1] Excerpted from the *Special Report for the FAA, Ranking the Hazard Level of Wildlife Species to Civil Aviation in the USA: Update #1, July 2, 2003.* Refer to this report for additional explanations of criteria and method of ranking.

[2] Aircraft incurred at least some damage (destroyed, substantial, minor, or unknown) from strike.

[3] Aircraft incurred damage or structural failure that adversely affected the structure strength, performance, or flight characteristics and that would normally require major repair or replacement of the affected component, or the damage sustained makes it inadvisable to restore aircraft to airworthy condition.

[4] Aborted takeoff, engine shutdown, precautionary landing, or other.

[5] Relative rank of each species group was compared with every other group for the three variables, placing the species group with the greatest hazard rank for $\geq$ 2 of the 3 variables above the next highest ranked group, then proceeding down the list.

[6] Percentage values, from Tables 3 and 4 in Footnote 1 of the *Special Report*, for the three criteria were summed and scaled down from 100, with 100 as the score for the species group with the maximum summed values and the greatest potential hazard to aircraft.

Binoculars are essential for detailed, close-up observations sometimes necessary for identification as well as for the detection and identification of birds or other wildlife at a distance. Provide WCP with a quality pair of binoculars, and train WCP in their use.

Equip each WCP with his or her own bird identification field guide, to be carried in the vehicle while on patrol. As a learning aid, encourage WCP to make annotations in their field guides regarding behavior or appearance next to identified birds.

There are a number of excellent field guides available from bookstores, some of which are listed at the end of this chapter. There are also bird identification guides available on CDs that provide useful life history information and vocalizations.

Grass areas at airports often contain several species of small mammals that are an attractive food for hawks, owl, herons, and egrets. Vagrant shrews, deer mice, gray-tailed voles, and Townsend's voles (left to right) were all captured during one night of trapping at a western USA airport in September 2003 (photo by R. A. Dolbeer, USDA).

8.2.B MAMMAL IDENTIFICATION

Unlike birds, there are typically only a few mammal species of importance on an airport. Train WCP to identify, not only by sight but also by sign (e.g., tracks, burrows, and fecal material), the common large and mid-sized mammals (e.g., deer, raccoons, woodchucks, coyotes) that live around the airport. Train WCP to identify signs (e.g., trails in grass, burrows) indicative of a population eruption of field rodents, such as voles, deer mice, or rats. A survey by a biologist using snap traps might be necessary to identify the species and relative abundance of rodents occupying various airport habitats. In addition, rodent species can be identified by examination of skull remains in pellets (boluses) regurgitated by hawks and owls. These pellets are often found on the ground beneath perching sites used by raptors.

Citations for field guides covering mammals and their tracks throughout the USA are provided at the end of this chapter. In addition, there are many state and regional field guides for identifying mammals and their signs. A good field guide to mammals is a necessary part of any airport's hazardous wildlife control library.

8.2.C BASIC LIFE HISTORIES AND BEHAVIOR OF COMMON SPECIES

In addition to learning to identify the hazardous birds and mammals on the airport, WCP should have some understanding of the biology and behavior of these species. This information will make the job of wildlife hazard management more interesting and be useful in anticipating problems and deploying control measures more effectively.

For each species of bird, it is important to know if it is present year round or only in summer, in winter, or during migration. For example, in which habitats and at what time of year do locally breeding bird species nest and when are young fledged from nests? What are the daily movement patterns between roosting, feeding and loafing areas in relation to the airport? What are the feeding behaviors and food preferences of each species on the airport? Which habitats does each species prefer? How does weather influence the presence and behavior of various species on the airport? How does each species react to approaching aircraft and to various repellent devices? By being observant and noting the behavior of these hazardous species, useful insights can be gained that will lead to more effective habitat management or repellent strategies.

Most bird and mammal field guides provide information on geographic range, feeding habits, and habitat preferences for each species. Alsop (2001), Sibley (2001), and Ehrlich et al. (1988) provide concise summaries of life history information (nesting, feeding, habitat preferences) for most birds in North America. Appendix J provides some life history facts for various gull species in the USA. Such books and fact sheets provide an excellent starting point for knowledge about a species. However, the most useful information will come from careful observation of what the birds and mammals are doing on your airport.

Canada geese have adapted to nesting on rooftops, often well away from water (photo courtesy USDA).

8.2.D WILDLIFE AND ENVIRONMENTAL LAWS AND REGULATIONS

As presented in Chapter 4, there is a complexity of federal and state laws protecting wildlife and regulating the issuance of permits to take (capture or kill) individuals causing problems. In addition, environmental laws and regulations regarding pesticide applications, drainage of wetlands, and endangered species must be considered in implementing Wildlife Hazard Management Plans. All WCP should have a basic understanding of the federal Migratory Bird Treaty Act (MBTA) whereby almost all native migratory birds are protected regardless of their abundance (see Chapter 4). WCP must understand that federal and often state permits must be issued before protected species can be taken on an airport. WCP must know that wild mammals are regulated at the state level, which may require permits for activities involving removal (killing or trapping/relocating). Non-native birds, such as pigeons, house sparrows, and starlings, and gallinaceous game birds, such as turkeys, grouse, and pheasants, are not protected by the MBTA but often have state protection. WCP involved in taking any wildlife species must have a clear understanding of which species have no legal protection and, for all others, the species and numbers allowed to be taken under permits issued. Permits also will list the methods of removal allowed and acceptable procedures for disposing of removed wildlife. Detailed records must be maintained of wildlife taken under permit.

8.2.E WILDLIFE CONTROL TECHNIQUES

Chapter 9 provides a brief description of most wildlife control techniques used on airports. WCP will need training to deploy these techniques safely and effectively.

The use of pyrotechnics, such as cracker shells fired from a 12-gauge shotgun (left) or screamers fired from a pistol launcher, should be part of an airport's integrated management program to disperse hazardous birds. Occasional lethal control by shooting might be necessary to reinforce pyrotechnics and other nonlethal dispersal techniques used against common species such as gulls and Canada geese. Permits and proper training must be in place before lethal control is implemented (photos by R. A. Dolbeer, USDA).

Firearms. It is critical that only personnel trained in the use of firearms, authorized under depredation permit, and knowledgeable in field identification of the target and similar-looking non-target species are allowed to use firearms on the airport. Skill, experience, and the proper equipment are needed to be safe and to maximize the effectiveness of a shooting program, whether it is to remove specific problem animals or to kill one or more individuals to reinforce repellent techniques. All discharged shell casings are potential Foreign Object Debris (FOD) and must be picked up.

Pyrotechnics. Pyrotechnics can cause injury or damage if discharged incorrectly or carelessly. For example, serious injuries have occurred when pyrotechnics were accidentally discharged inside vehicles. Proper equipment (safety glasses, ear protection) and training is essential for safe use of pyrotechnics. In addition, training is needed to deploy the correct pyrotechnic for each situation and wildlife species and to minimize habituation. It is critical that pyrotechnics (and other repellent devices) not be deployed in situations where the birds or mammals might be flushed into the path of departing or arriving aircraft.

Pesticide application. WCP applying restricted-use pesticides, applying pesticides for hire, or applying pesticides to the land of another must be Certified Applicators or working under the direct supervision of a Certified Applicator and then may only use pesticides covered by the Certified Applicator's certification. Proper application equipment and safety clothing must be used. Detailed records of pesticide applications must be maintained.

Propane cannons can be used as part of an integrated program to disperse birds from airports. However, birds quickly habituate to the loud bangs if the cannons are used continuously and not integrated with other frightening devices (photo by R. A. Dolbeer, USDA).

For information on the training requirements for becoming a Certified Pesticide Applicator, contact the State University Cooperative Extension Service.

Distress call tapes, propane cannons, and miscellaneous techniques. As emphasized in Chapter 9, a major problem in the use of repellent techniques or devices is habituation of the wildlife species to the threats. These techniques all require training for their proper deployment. The most critical factor for most repellent devices is that they be deployed sparingly and appropriately when the target wildlife is present and be reinforced occasionally by a real threat such as shooting. More detailed information on the use of various repellent devices is presented in Chapter 9 and Hygnstrom et al. (1994).

8.2.F RECORD KEEPING AND STRIKE REPORTING

A key component of a Wildlife Hazard Management Plan is developing a system to (1) document the daily activities of WCP, (2) log information about wildlife numbers and behavior on the airport, and (3) record all wildlife strikes with aircraft. This information is essential to document the effort being made by the airport in reducing wildlife hazards. The information is also extremely useful during periodic evaluations of the Wildlife Hazard Management Plan and when revisions to the plan are proposed. Instruct WCP on the importance of record keeping and train them to record this information in a standardized format. Chapter 7 provides more details about record keeping and wildlife strike reporting.

8.3 SOURCES OF TRAINING

Wildlife control workshops at airports. Books, manuals, and videos can provide a starting point for building skills to manage hazardous wildlife on airports. However, hands-on training is essential to develop the necessary skills and confidence to successfully and safely carry out wildlife control activities. Workshops on airport wildlife control offered by the USDA/WS or other entities are an excellent means of obtaining training in wildlife identification, legal issues, and the deployment of various control techniques specific for a given airport or region of the country. These workshops can be held for all WCP at a single airport or at a centralized airport with participants coming from airports throughout the state or region.

A special classroom and field training program in the proper and safe use of pyrotechnics to disperse birds was provided at the 2002 and 2004 meetings of Bird Strike Committee–USA/Canada (photos by R. DeFusco).

Contact the Wildlife Services office in your state (Appendix A) for more information.

Bird Strike Committee USA meetings. Bird Strike Committee–USA (BSC–-USA) holds joint meetings annually with Bird Strike Committee Canada at a USA or Canadian airport. This annual meeting provides an excellent forum to discuss the latest issues and techniques in wildlife control for airports. The meeting includes a field trip to the host airport with demonstrations by vendors and wildlife specialists of various wildlife control equipment and techniques. Chapter 3 provides more information on BSC–USA. Information on annual meetings, as well as information on various aspects of wildlife hazard management for airports, can be found at BSC–USA's web site: www.birdstrike.org.

Hunter safety and firearms courses. Require airport personnel who will be using firearms to complete a hunter safety or firearms safety course. The state wildlife agency can provide information on these courses.

Miscellaneous courses and activities. Many universities and some community colleges offer courses in ornithology, principles of wildlife management, principles of wildlife damage control, or other related topics. Local Audubon Society chapters or park districts sometimes offer workshops or short courses in field identification of birds. Participation in conservation organization activities, such as Christmas Bird Counts and spring migration counts, is an excellent means of building bird identification skills and developing contacts with local wildlife experts.

Birds and mammals are not the only wildlife groups that can cause problems on airports. This 7-foot alligator wandered onto the runway at a southern USA airport in September 2002, threatening both aircraft and personnel. The alligator was relocated unharmed. For the 14-year period 1990–2003, reports of 15 alligator-aircraft strikes with civil aircraft were received by the FAA (photo by J. Metcalf).

8.4 WILDLIFE HAZARD MANAGEMENT LIBRARY

Establish a designated location for reference books, such as wildlife field guides, videos, posters, and other training and educational materials and the airport's Wildlife Hazard Management Plan if one has been developed. Ideally, locate this wildlife library at the site where information on wildlife control activities and wildlife strikes is entered into logs, files, and databases.

8.5 FIELD GUIDES AND REFERENCE BOOKS

There are many excellent field guides and reference books for learning about wildlife. To provide examples, a selection of books that cover North America or large regions of the USA is listed below. This list is not intended as an endorsement of these books to the exclusion of others. There are also many field guides for individual states and specialized books for various wildlife species or species groups.

Field Guides–Birds

Bull, J., J. Farrand, Jr., and, L. Hogan. 1994. *National Audubon Society field guide to North American birds: Eastern region.* Alfred Knopf, New York, New York. 796 pages. 2nd edition.

Airports should maintain a small library of field guides that can be referenced by biologists and operations personnel to identify and learn about birds, mammals, plants, and insects found on the airport. These field guides should be located with the Wildlife Hazard Management Plan and other related documents (photo by B. Washburn, USDA).

National Geographic Society. 2002. *Field guide to the birds of North America.* National Geographic Society, Washington, District of Columbia. 480 pages. 4th edition.

Griggs, J. L. 1997. *All the birds of North America: American Bird Conservancy's field guide.* Harper Collins, New York, New York. 172 pages.

Peterson, R. T. 1998. *A field guide to the birds: a completely new guide to all the birds of Eastern and Central North America.* Houghton Mifflin Company, New York, New York. 384 pages. 4th edition.

Peterson, R. T. 1990. *A field guide to Western birds: a completely new guide to field marks of all species found in North America west of the 100th meridian and north of Mexico.* Houghton Mifflin Company, New York, New York. 431 pages. Reissue edition.

Robbins, C. S., B. Bruun, and H. S. Zim. 1983. *Birds of North America.* Golden Press, New York, New York. 360 pages.

Field Guides - Mammals

Burt, W. H., and R. P. Grossenheider. 1998. *A field guide to the mammals: North America north of Mexico.* Houghton Mifflin Company, New York, New York. 3rd edition. 289 pages.

National Audubon Society. 2000. N*ational Audubon Society field guide to North American mammals* (revised and expanded). Alfred Knopf, New York, New York. 937 pages.

Elbroch, M. 2003. *Mammal tracks and sign: A guide to North American species.* Stackpole Books, Mechanicsburg, Pennsylvania. 792 pages.

Murie, O. J. 1954. *A field guide to animal tracks.* Houghton Mifflin Company, New York, New York. 374 pages.

Life Histories

Alsop, F. J., III. 2001. *Birds of North America, Eastern Region* (751 pages), *Western Region* (752 pages). DK Publishing, Inc., New York, New York.

An examination of the stomach contents of aircraft-struck birds found on runways can often identify food sources that are attracting the birds to the airport. A chicken neck and undigested French-fried potato found in this laughing gull stomach indicated a nearby source of uncovered garbage (photo by G. E. Bernhardt, USDA).

Ehrlich. P. R., D. S. Dobkin, and D. Wheye. 1988. *The birder's handbook: a field guide to the natural history of North American birds, including all species that regularly breed north of Mexico.* Simon and Schuster, New York. 785 pages.

Chapman, J. A., and G. A. Feldhamer (editors). 1982. *Wild mammals of North America.* Johns Hopkins University Press, Baltimore, Maryland. 1,147 pages.

Sibley, D. A. 1991. *The Sibley guide to bird life and behavior.* Alfred A. Knopf, New York, New York. 580 pages.

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CHAPTER 9: WILDLIFE CONTROL STRATEGIES AND TECHNIQUES AT AIRPORTS

A B-767 departing an east coast USA airport in October 2002 ingested at least one double-crested cormorant into the #2 engine. Parts of the engine broke loose and penetrated the engine casing, resulting in an uncontained engine failure. The strike also damaged the landing light and leading edge of the right wing. The cormorant population increased at an annual rate of 7% in the USA from 1980–2004.

9.1 INTRODUCTION

No airport or aircraft type is immune from the hazards of wildlife strikes. Many species of birds and mammals have been involved in damaging strikes (Chapter 2). A flock of starlings suddenly rising from the ground, a lone kestrel hovering in search of prey, a pair of Canada geese taking flight after grazing in the infield, or a deer bounding across a runway—all can result in significant aircraft damage or in extreme cases, a crash and loss of human lives. In addition to strikes, wildlife that are roosting, nesting, or burrowing on airports can cause structural damage to buildings, equipment, and aircraft as well as nuisance and health problems for workers and passengers.

As discussed in Chapters 5 and 6 about the conduct of Wildlife Hazard Assessments and development of Wildlife Hazard Management Plans, the first step in solving any wildlife damage problem is to answer the following nine questions for each species:

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

There should be zero tolerance for nesting by Canada geese and other large birds at airports. Permits should be in place so any nests discovered can be destroyed immediately and adult nesting birds dispersed or removed (photo by R. White, USDA).

9. What are public attitudes toward the problem wildlife species and the hazards that these species pose? Public opinion also may influence the type of management actions taken.

Elimination of wildlife habitat and attractants on or near airports will reduce wildlife strikes. Exposed I beams, such as used in the canopy over the passenger pick-up area at a Midwestern USA airport, make ideal roosting habitat for flocks of European starlings (photo by R. White, USDA).

This chapter presents the overall approach to be taken when managing wildlife hazards on airports. Once the overall approach is established, the chapter outlines the strengths and weaknesses of various wildlife control methods recommended for use on airports, as well as certain methods that should not be used. This chapter is not the final word on this subject. Wildlife damage control is a dynamic field, and new products, technologies, and innovations are continuously being introduced. In addition, changes in the legal status of control techniques, chemical registrations, and wildlife species occur at the federal and state level. Thus, this chapter is only a starting point for information on wildlife control techniques.

It is recommended that this chapter be used in conjunction with the two-volume manual *Prevention and Control of Wildlife Damage* published in 1994 by Cooperative Extension, University of Nebraska at Lincoln (see full citation at end of this chapter). This manual, written by various experts in the field of wildlife damage control, provides detailed information on the techniques, equipment, chemical registrations, species-specific management recommendations, and sources of supply for the various control strategies presented in this chapter. This manual is also available online in a periodically updated version at: ianrwww.unl.edu/wildlife/solutions/handbook/.

9.2 WILDLIFE CONTROL STRATEGIES

Four basic control strategies are available to solve wildlife problems on airports:

1. Aircraft flight schedule modification;
2. Habitat modification and exclusion;
3. Repellent and harassment techniques; and
4. Wildlife removal.

Integrate all four control strategies into the Wildlife Hazard Management Plan as appropriate.

9.2.A AIRCRAFT FLIGHT SCHEDULE MODIFICATION

Although not generally practical for regularly scheduled commercial traffic on larger airports, there may be various situations when flight schedules of some aircraft can be adjusted to minimize the chance of a strike with a wildlife species that has a predictable pattern of movement. For example, pilots could be advised not to depart during a 20-minute period at sunrise or sunset during winter when large flocks of blackbirds cross an airport going to and from an off-airport roosting site. In situations such as at Midway Atoll where albatrosses and other seabirds are abundant during parts of the year, scheduling nighttime arrivals and departures, when birds are not flying, might be the only means of avoiding strikes. Finally, air traffic controllers on occasion might need to temporarily close a runway with unusually high bird activity or a large mammal (e.g., deer) incursion until wildlife control personnel can disperse the animals.

Poles and other structures that are no longer in use should be removed from airport property. Such structures make ideal perching sites for hawks and owls searching for prey. The pellets at the base of this pole are undigested fur and bones of rodents that were regurgitated by red-tailed hawks (photo by R. A. Dolbeer, USDA).

9.2.B HABITAT MODIFICATION AND EXCLUSION

Habitat modification means changing the environment to make it less attractive or inaccessible to the problem wildlife. All wildlife require food, cover, and water to survive. Any action that reduces, eliminates, or excludes one or more of these elements will result in a proportional reduction in the wildlife population at the airport. Habitat modifications to make the airport and surrounding area as unattractive as possible to hazardous wildlife must be the foundation of every airport's Wildlife Hazard Management Plan.

Initially, management actions to reduce food, cover, and water on an airport might be expensive. However, when costs are amortized over several years, these actions might be the least expensive approach to reducing wildlife populations on the airport. Once a habitat modification is done correctly, it is generally not necessary to go back and do it again. Also, these control methods are generally well accepted by the public and minimize the need to harass or kill wildlife on the airport.

9.2.B.I FOOD

Some of the more common urban food sources for birds on and near airports include handouts from people in taxi stands and parks, grain elevators, feed mills, sewer treatment plants, and improperly stored food waste around grocery stores, restaurants, and catering services. Rural food sources attractive to birds include sanitary landfills, feedlots, certain agricultural crops (especially cereal grains and sunflower), and spilled grain along road and rail rights-of-way.

Be aware of food attractants for birds that exist on and in proximity to the airport. On the airport, require bird-proof storage of food waste, prohibit bird feeding, and promote good sanitation and litter control programs.

Gulls and other birds concentrate at locations where people regularly provide food such as bread and seeds. Feeding birds should be prohibited on and in the vicinity of airports (photo by R. White, USDA).

Because most, if not all, agricultural crops can attract hazardous wildlife during some phase of production, the FAA recommends against the use of airport property for agricultural production, including hay crops, within the separations identified in Chapter 5, § 5.2. If the airport has no financial alternative to agricultural crops to produce income necessary to maintain the viability of the airport, then the airport must follow the crop distance guidelines listed in the table titled "Minimum Distances between Certain Airport Features and Any On-Airport Agricultural Crops" found in AC 150/5300-13, *Airport Design*, Appendix 19 (see Appendix C). Weigh the cost of wildlife control and potential accidents against the income produced by the on-airport crops when deciding whether to allow crops on the airport (AC 150/5200-33A) (see Chapter 5 and Appendix C). For nearby off-airport areas, work closely with local governmental entities and landowners to discourage land-use practices and activities that provide food sources for problem bird species.

Do not use trees and other landscaping plants for the street side of airports that produce fruits or seeds attractive to birds. On airside areas, the large expanses of grass and forbs can sometimes provide ideal habitat for rodent and insect populations that attract raptors, gulls, other bird species, and mammalian predators such as coyotes. In addition, grasses allowed to produce seed heads can provide a desirable food source for doves, blackbirds, and other flocking species. The management of airside vegetation to minimize rodents, insects, and seeds might be complex, requiring insecticide, herbicide, and rodenticide applications; changes in vegetation cover; and adjustments in mowing schedules (e.g., mowing at night to minimize bird feeding on insects exposed by the mowing). Such management plans will need to be developed in conjunction with professional wildlife biologists and horticulturists knowledgeable with the local wildlife populations, vegetation, and growing conditions (see below).

9.2.B.II COVER

All wildlife require cover for resting, roosting, escape, and reproduction. Non-migratory Canada geese in urban areas, left undisturbed, will establish territories on corporate lawns, golf courses, and even building roofs associated with nearby ponds. Pigeons, house sparrows, and European starlings use building ledges, abandoned buildings, open girders and bridge work, and dense vegetation for cover. Blackbirds use marsh vegetation, such as cattails, for nesting and roosting. Many bird problems can be solved by eliminating availability of such areas either through removal or by exclusion.

The maintenance of monotypic, uniform stands of tall (e.g., 10-inch) grass is difficult and expensive at most airports, requiring fertilizer, herbicides, and water (photo by R. A. Dolbeer, USDA).

Take care when selecting and spacing plants for airport landscaping. Avoid plants that produce fruits and seeds desired by birds. Also avoid the creation of areas of dense cover for roosting, especially by European starlings and blackbirds. Thinning the canopy of trees, or selectively removing trees to increase their spacing, can help eliminate bird roosts that form in trees on airports.

The management of an airport's airside ground cover to minimize bird activity is a controversial subject in North America. The general recommendation, based on studies in England in the 1960s and 1970s, has been to maintain a monoculture of grass at a height of 6-10 inches (Transport Canada) or 7-14 inches (U.S. Air Force). Tall grass, by interfering with visibility and ground movements, is thought to discourage many species of birds from loafing and feeding. However, the limited studies conducted in North America have not provided a consensus of opinion on the utility of tall-grass management for airports. For example, Canada geese do not appear to be discouraged by tall grass. In addition, maintenance of tall grass can result in increased rodent populations, a food source for raptors. Finally, maintenance of monotypic, uniform stands of tall grass is difficult and expensive on many airports because of varying soil conditions and the need for fertilizer and herbicide applications. Arid regions in the western USA cannot maintain tall grass without irrigation.

A promising approach to reducing wildlife attraction to airport ground cover, irrespective of the height, is the use of vegetation that is undesirable or mildly toxic to wildlife. For example, there are varieties of fescue grass that contain fungal endophytes. Some of these endophytes are unpalatable to grazing birds, such as geese, as well as to rodents and deer. These endophytic grasses might also support fewer insect numbers. Other ground cover, such as wedelia or Bermuda grass, might be appropriate for subtropical airfields. Finally, artificial (synthetic) turf in selected areas might be useful in providing a more sterile environment for wildlife at airports.

Until more research is completed, no general guidelines on grass height or vegetation type for airside ground cover will be made. See Appendix O, Summary of Studies on Vegetation Management for North American Airfields, for a literature review of the current state of knowledge on airport grass management. Consult with professional wildlife hazard management biologists and horticulturists to develop a vegetation type and mowing schedule appropriate for the growing conditions and wildlife at the location. The main principles to follow are to use a vegetation cover and mowing regime that do not result in a build-up of rodent numbers or the production of seeds, forage, or insects desired by birds.

Finally, dense stands of trees and undergrowth on airport property can provide excellent cover for deer, coyotes, nesting geese and raptors, roosting blackbirds, rodents, and other wildlife. In general, clear or at least sufficiently thin these habitats to eliminate the desired cover and to allow easy visual and physical access by wildlife control personnel. Remove all unnecessary posts, fences, and other structures that can be used as perches by raptors and other birds. Piles of construction debris and discarded equipment, unmowed fence rows, and other unmanaged areas are not only esthetically unpleasing but typically provide excellent cover for commensal rodents (rats and house mice) and den sites for woodchucks, feral dogs and coyotes. Eliminate such areas on airports.

Standing water is a strong attractant to waterfowl, gulls, and wading birds such as egrets and herons. Airport managers should strive to eliminate all standing water (photo by R. A. Dolbeer, USDA).

9.2.B.III WATER

Water acts as a magnet for birds; therefore, eliminate all standing water on an airport to the greatest extent possible. Fill or modify to allow rapid drainage of depressions in paved and vegetated areas, and disturbed areas at construction sites that accumulate standing water after rain. This is particularly important at coastal airports where fresh water is highly attractive to birds for drinking and bathing. Do not establish retention ponds, open drainage ditches, outdoor fountains and other wetland sites on or adjacent to airports.

Where possible, modify storm water detention ponds to allow a maximum 48-hour detention period for the design storm. Avoid or remove retention ponds and detention ponds featuring dead storage to eliminate standing water. Design detention basins to remain totally dry between rainfalls. Where constant flow of water is anticipated through the basin, or where any portion of the basin bottom might remain wet, design the detention facility to include a concrete or paved pad and/or ditch/swale in the bottom to prevent vegetation that might provide nesting habitat.

When it is not possible to drain a large detention pond completely, use physical barriers, such as bird balls, wires grids, pillows, or netting, to deter birds and other hazardous wildlife. Evaluate the use of physical barriers and ensure they will not adversely affect water rescue. Before installing any physical barriers over detention ponds on Part 139 certificated airports, obtain approval from the appropriate FAA Regional Airports Division Office.

Birds are permanently excluded from this storm water detention facility through the use of a floating permeable barrier (Photo courtesy Industrial & Environmental Concepts, Inc.).

Encourage off-airport storm water treatment facility operators to incorporate appropriate wildlife hazard mitigation techniques into their operating practices when the facility is located within the separation criteria specified in AC 150/15200-33A (see 5-2 above and Appendix C).

9.2.B.IV EXCLUSION TECHNIQUES

If food, water, or cover cannot be eliminated by habitat modification, then actions can sometimes be taken to exclude the wildlife from the desired resource. Exclusion involves the use of physical barriers to deny wildlife access to a particular area. As with habitat modification, exclusion techniques, such as installing a covered drainage ditch instead of an open ditch, can initially be costly. However, exclusion provides a permanent solution that is not only environmentally friendly, but when amortized over many years, might actually be the least expensive solution.

Light posts and other structures in taxicab lots at airports can be fitted with anti-perching devices to discourage gulls and other birds from using the area. Feeding of birds should also be prohibited on airport property.

9.2.B.IV.A EXCLUSION OF BIRDS

Architects should consult biologists during the design phase of buildings, hangers, bridges, and other structures at airports to minimize exposed areas that birds can use for perching and nesting. For example, tubular steel beams are much less attractive as perching sites for starlings and pigeons than are I-beams. If desirable perching sites are present in older structures, access to these sites (such as rafter and girded areas in hangers, warehouses, and under bridges) often can be eliminated with netting. Curtains made of heavy-duty plastic sheeting, cut into 12-inch strips, and hung in warehouse or hanger doorways, can discourage birds from entering these openings. Anti-perching devices, such as spikes, can be installed on ledges, roof peaks, rafters, signs, posts, and other roosting and perching areas to keep certain birds from using them. Changing the angle of building ledges to 45 degrees or more will deter birds. However, it is emphasized that incorporating bird exclusion or deterrence into the design of structures is the most effective, long-term solution.

Gull and waterfowl use of retention ponds and drainage ditches can be reduced with over-head wire systems. A system of wires spaced 10 feet apart or in a 10- x 10-foot grid will discourage most gulls and waterfowl from landing. Similar wire systems have been successfully used to keep gulls off roofs and out of landfills and crows out of electrical substations. When it is desirable to eliminate all bird use, netting can be installed over small ponds and similar areas. However, birds are sometimes tangled in the netting and maintenance problems arise with high winds and freezing weather. Complete coverage of ponds with plastic, 3-inch diameter "bird balls" or floating mats will completely exclude birds and yet allow evaporation of water. Designing ponds with steep slopes will discourage wading birds such as herons. Use of culverts to totally cover water in drainage ditches is recommended whenever possible.

A well-maintained fence, at least 10-feet high with no gaps at the bottom, is the primary defense to keep deer and other large animals off of the AOA at airports. Gates must also be close-fitting, and water drains under the fence must be equipped with exclusion devices (top photo by E. Cleary, FAA).

9.2.B.IV.B EXCLUSION OF MAMMALS

Institute a "zero tolerance" policy for deer, livestock, and other large mammals in the AOA because of their severe threat to aviation safety (see Table 8-1). The best, albeit most costly, procedure for excluding these animals off the AOA is proper fencing. The FAA recommends a 10-12 foot chain link fence with 3-strand barbed wire outriggers. In some cases, an airport might be able to use an 8-foot chain link fence with 3-strand barbed outriggers, depending on the amount of deer activity in the area (see Certalert No. 04-16, Appendix E). A 4-foot skirt of chain-link fence material, attached to the bottom of the fence and buried at a 45^o angle on the outside of the fence will prevent animals from digging under the fence and reduce the chance of washouts. This type of fencing also greatly increases airport security. There are also numerous electric-fence designs for excluding deer, discussed in Hygnstrom et al. (1994), that are not as costly as permanent fencing but have drawbacks in safety and maintenance.

Properly install and maintain all fencing. Keep the fence line right-of-way free of excess vegetation. Patrol the fence line at least daily, and fix any washouts, breaks, or other holes in the fence as soon as they are discovered. Take immediate action to remove any deer or other large mammals observed on or near the AOA.

Cattle Guards are widely used to prevent hoofed livestock from traversing across fenced areas through permanent openings maintained for vehicular access. These devices, if at least 15 feet in length perpendicular to the fence, will prevent deer from entering through gated areas on airports.

9.2.C REPELLENT TECHNIQUES

Repellent and harassment techniques are designed to make the area or resource desired by wildlife unattractive or to make the wildlife uncomfortable or fearful. Long term, the cost-effectiveness of repelling wildlife usually does not compare favorably with habitat modification or exclusion techniques. No matter how many times wildlife are driven from an area that attracts them, they or other individuals of their species will return as long as the attractant is accessible. However, habitat modifications and exclusion techniques will never completely rid an airport of problem wildlife; therefore, repellent techniques are a key component of any wildlife hazard management plan.

Under low-light conditions, specially designed lasers can be effective in dispersing geese, cormorants, and other bird species.

Repellents work by affecting the animal's senses through chemical, auditory, or visual means. Habituation or acclimation of birds and mammals to most repellent devices or techniques is a major problem. When used repeatedly without added reinforcement, wildlife soon learn that the repellent devices or techniques are harmless. The devices become a part of their "background noise", and they ignore them.

Critical factors to be recognized in deploying repellents are—

1. There are no "silver bullets" that will solve all problems;
2. Likewise, there is no standard protocol or set of procedures that is best for all situations. Repelling wildlife is an art as much as a science. The most important factor is having motivated, trained, appropriately equipped personnel who understand the wildlife situation on their airport;
3. Each wildlife species is unique and will often respond differently to various repellent techniques. Even within a group of closely related species, such as gulls, the

various species will often respond differently to various repellent techniques; and

4. Habituation to repellent techniques can be minimized by—
   a) using each technique sparingly and appropriately when the target wildlife is present,
   b) using a variety of repellent techniques in an integrated fashion, and
   c) reinforcing repellents with occasional lethal control (with necessary permits in place) directed at abundant problem species such as gulls or geese.

Advances in electronics, remote sensing capabilities, and computers are resulting in the development of "intelligent" systems that can automatically deploy repellent devices (e.g., noisemakers, chemical sprays) when targeted wildlife enter a designated area. These devices might help reduce habituation and increase effectiveness of repellents in some situations. However, these devices will never replace the need for trained people on the ground to respond appropriately to incursions by a variety of highly adaptable, sentient wildlife species.

9.2.C.I WILDLIFE PATROLS AND RUNWAY SWEEPS IN VEHICLES

Regular patrols of airside areas to disperse birds and other hazardous wildlife are a critical component of an integrated program of wildlife hazard management on airports. Often, driving a vehicle toward the wildlife will be enough to cause the wildlife to disperse, especially if the driver has been deploying repellent and removal techniques and strategies as outlined below. Regular patrols and sweeps also permit wildlife control personnel to learn the daily movement patterns, habitat preferences, and behavior of wildlife on the airport. This information can be useful in determining wildlife attractants on the airport that need to be removed (e.g., low areas that gather standing water after rains) and in anticipating problem situations. All wildlife carcasses found during runway sweeps should be removed, identified to species, and documented on a wildlife strike log for carcass remains (Table 7-2).

Chemical repellents, such as methyl anthranilate, can be applied to temporary pools of standing water on airports to repel birds until the water evaporates. The preferred long-term solution is to improve drainage to avoid standing water after significant rain events (photo courtesy USDA).

9.2.C.II CHEMICAL REPELLENTS FOR BIRDS

Chemical repellents, toxicants, and capturing agents must be registered with the U.S. Environmental Protection Agency (USEPA) or Food and Drug Administration (FDA) before they can be used to manage wildlife on airports. Products must also be registered in each state. Hygnstrom et al. (1994) provides a listing of chemical products, by active ingredient and by company name, registered for birds and mammals. The following chemical repellents, listed by active ingredient, are presently available for use on airports.

Perching structures (polybutenes). Several commercial products are available in liquid or paste form. These sticky formulations make birds uncomfortable when they alight on them, encouraging the birds to look elsewhere to perch or roost. To be effective, all perching surfaces in a problem area must be treated, or the birds will move a short distance to an untreated surface. Under normal conditions, the effective life of these materials is 6 months to 1 year. Dusty environments can substantially reduce the life expectancy. Once the material loses effectiveness, it is necessary to remove the old material and apply a fresh coat. Applying the material over duct tape, rather than directly to the building ledge or rafter surface, will facilitate clean up.

Turf feeding (methyl anthranilate, anthraquinone). There are two chemicals presently (2005) registered as bird repellents for turf (grass). One repellent is an anthraquinone formulation for repelling geese from turf. Anthraquinone apparently acts as a conditioned-aversion repellent with birds. Birds ingesting food treated with anthraquinone become slightly ill and develop a post-ingestion aversion to the treated food source. Birds visually identify anthraquinone in the UV light spectrum and become conditioned to avoid the treated food source. Because of its conditioned-aversion properties, anthraquinone use does not require treatment of the entire airfield, but only areas where birds are grazing and/or higher risk areas such as runway approaches.

The other repellent is methyl anthranilate, an artificial grape flavoring commonly used in foods and beverages. Birds have a taste aversion to methyl anthranilate, apparently reacting to it in much the same way that mammals react to concentrated ammonia (smelling salts). Methyl anthranilate is registered under formulations as a feeding repellent for geese and other birds on turf.

A recent study showed that predator urines (coyote, bobcat) had no influence on deer movements along established trails or at feeding sites (photo by T. Seamans, USDA).

Both anthraquinone and methyl anthranilate products are liquid formulations applied by sprayer to the vegetation. Effectiveness of these sprays in repelling geese can be variable, depending on growing conditions, rainfall, mowing, and availability of alternate feeding areas. In general, repellency based on conditioned aversion is longer lasting than repellency based on taste.

Water (methyl anthanilate). Methyl anthranilate formulations are also available for application to pools of standing water on airports and at other locations to repel birds from drinking and bathing. This application is probably best for temporary pools of water after rainfall, where repellency of only a few days is needed.

General area (fogging with methyl anthanilate). A methyl anthranilate formulation is also available for use in fogging machines (thermal or mechanical) to disperse birds from hangers, lawns, and other areas.

Frightening agent (Avitrol [4-Aminopyridine]). Avitrol is registered for repelling pigeons, house sparrows, black-birds, grackles, cowbirds, starlings, crows, and gulls from feeding, nesting, loafing, and roosting sites. Birds eating Avitrol-treated baits react with distress symptoms and calls, behaviors that frighten away other birds in the flock. Avitrol, although registered as a “frightening agent”, is lethal to the birds that eat treated baits. Therefore, recognize that Avitrol is a toxic to the birds that consume treated bait. Avitrol-treated bait is diluted with untreated bait so most birds in the flock do not ingest treated bait. The primary use of Avitrol at airports has been in pigeon control around buildings. The use of Avitrol requires knowledge of the feeding patterns of the birds, proper prebaiting procedures to ensure bait acceptance and avoidance of non-target species, and removal of dead birds after treatment.

9.2.C.III CHEMICAL REPELLENTS FOR MAMMALS

In most cases, birds rapidly adapt to and then ignore recorded distress calls and other noises produced by electronic auditory devices. Such devices, as shown on the pole in the photo, can be useful only if used sparingly as part of an integrated program of bird dispersal (photo by R. A. Dolbeer, USDA).

There are a number of taste and odor repellents marketed to repel deer, rabbits, and other mammals from browsing on vegetation (Hygnstrom et al. 1994). These include products that are applied directly to the vegetation and general area (odor) repellents (e.g., predator urine). Some of these products might be appropriate for short-term protection of valuable landscaping plants and fruit trees. However, their use on airports to repel or discourage deer or other mammals is not recommended because they are unlikely to have any influence on wildlife movements in the airport operating area.

9.2.C.IV AUDIO REPELLENTS FOR BIRDS

Propane cannons. Propane cannons (exploders) generate a shotgun-sounding blast. In general, birds quickly habituate to cannons that detonate at systematic or random intervals throughout the day. Thus, to ensure they remain effective, use cannons sparingly and only when birds are in the area. Reinforcement by occasional killing a few birds (of common species such as gulls and Canada geese under an appropriate permit) with a shotgun might also enhance effectiveness. Systems designed so cannons placed around an airport can be detonated remotely on demand by radio signal when birds are in the area are a useful means of reducing habituation.

Distress-call and electronic noise-generating systems. Recorded distress calls are available for common birds on airports, such as gulls, crows, and starlings. Such calls, broadcast from speakers mounted on a vehicle, will often initially draw the birds toward the sound source to investigate the threat. The birds then can be dispersed by pyrotechnics or by using a shotgun to shoot an occasional bird. As with propane cannons, distress calls routinely broadcast from stationary speakers, with no associated follow-up stimuli that provide additional fear or stress, have little utility. Birds also habituate rapidly to other electronic sound systems that generate a variety of synthetic sounds from stationary speakers.

Shell crackers and other pyrotechnics. There are a variety of projectiles that can be fired from breech-loaded shotguns or from specialized launchers to provide an auditory blast or scream, as well as smoke and flashing light, to frighten birds. Some of the newer cartridges have ranges of up to 300 yards. These pyrotechnics, when used skillfully in combination with other harassment techniques and limited lethal control (shooting via shotgun), can be very useful in driving birds off of an airport. An advantage of these pyrotechnic devices is that they require a person to fire the projectile, thus ensuring that they are deployed directly at the target birds and that the birds associate the pyrotechnic with a threat (person).

Taxidermy mounts of coyotes deployed to move in the wind might be useful as part of an integrated program to disperse Canada geese and other birds from airports. Such effigies must be used sparingly and moved to various locations to prevent habituation. Permanently mounted effigies have little deterrent effect (photo by R. A. Dolbeer, USDA).

Ultrasonic devices. Ultrasonic (i.e., above the sound range detected by humans) devices have not proven to be effective bird repellents. In fact, most birds do not detect frequencies as high as humans can detect, much less frequencies above the level of human detection. During tests conducted by the U.S. Department of Agriculture's National Wildlife Research Center, pigeons showed no response when exposed within 10 feet to a fully functional, high-frequency sound generating device. Do not deploy these devices in hangers or other airport settings to deter birds.

9.2.C.V AUDIO REPELLENTS FOR MAMMALS

Probably the most commonly used audio scaring device for deer is the propane cannon. However, deer rapidly habituate to propane cannons. Their use on airports to repel deer and other mammals from runways is not recommended except for short-term (i.e., several days), emergency situations until a more permanent solution (fencing or deer removal) can be achieved. Other electronic noise-generating devices also have proven ineffective in repelling deer or other mammals for more than a few days. Pyrotechnics also provide only short-term repellency for mammals.

9.2.C.VI VISUAL REPELLENTS FOR BIRDS

Most visual repellents are simply a variation on an ancient theme—the scarecrow. In general, visual repellents, such as hawk effigies or silhouettes, eye-spot balloons, flags, and Mylar reflecting tapes, have shown only short-term effectiveness and are inappropriate for use as a long-term solution to bird problems on airports. Most short-term success achieved with these devices is likely attributable to "new object reaction" rather than to any actual frightening effect produced by them. For example, in a test in Ohio, a flag with a large eye-spot was exposed to pigeons in an abandoned building. As soon as the flag was put up, the pigeons left the building, giving the impression that the eye-spot was highly repellent to the birds. However, within 24 hours, the pigeons returned. From then on, the pigeons behaved in a completely normal fashion and showed no interest in, or reaction to, the flag.

The successful use of border collies to repel birds requires a high degree of dedication and commitment by the handlers. Jet was among the first border collies to successfully work at an airport to control birds.

One visual deterrent that has been successfully used in recent years is the display of dead birds in a "death pose." Several experiments and field demonstrations have shown that a dead turkey vulture (freeze-dried taxidermy mount with wings spread), hung by its feet in a vulture roosting or perching area, will cause vultures to abandon the site. Initial trials using dead gulls and ravens suspended from poles have also shown promising results in dispersing these species from feeding and resting sites. The dead bird must be hung in a "death pose" to be effective. Dead birds lying supine on the ground or in the roost are generally ignored or might even attract other birds. Permits must be in place before federally protected migratory birds can be obtained and used as "dead-bird deterrents." Research is under way to determine if artificial "dead-bird effigies" can be developed that will be just as effective as the taxidermy mounts.

Another new concept in visual repellency that has shown utility in recent years is the use of hand-held laser devices that project a 1-inch diameter red beam to disperse birds. These devises have been used successfully to disperse birds such as Canada geese, double-crested cormorants, and crows from nighttime roosting areas in reservoirs and trees. Advantages are effectiveness at long range (over ¼ mile) and lack of noise. Lasers have also shown some effectiveness in dispersing birds from hangers. Effectiveness is diminished or nonexistent in daylight conditions. As with the use of firearms, the use of lasers in an airport environment obviously requires caution.

9.2.C.VII VISUAL REPELLENTS FOR MAMMALS

For the most part, visual repellents such as flags and effigies have proven ineffective for repelling mammals. Their use is not recommended for keeping deer or other mammals off airports. Red lasers (see above) were ineffective in dispersing deer.

9.2.C.VIII TRAINED FALCONS AND DOGS TO REPEL BIRDS

Radio-controlled aircraft, such as this Robo-Falcon™, can be useful as part of an integrated program in dispersing birds from airports and landfills. Considerable training is required to operate these devices in the airport environment (photo by R. A. Dolbeer, USDA).

Trained falcons and other birds of prey have been used intermittently on various airports in Europe and North America to disperse birds since the late 1940s. The advantage of falconry is that the birds on the airport are exposed to a natural predator for which they have an innate fear. The disadvantage is that a falconry program is often expensive, requiring a number of birds that must be maintained and cared for by a crew of trained, highly motivated personnel. Furthermore, the effectiveness of falconry programs in actually reducing strikes has been difficult to evaluate.

Blokpoel (1976) outlined the following summary of falconry for airports that is still a good overall assessment: (1) properly trained birds of prey of the right species for the job at hand, used regularly and persistently by skilled and conscientious personnel, are effective in clearing birds from airfields during daylight and good weather; (2) for good results, daily operations on a year-round basis are required in most cases, (3) several falcons are required to have at least one bird ready at all times, and (4) to obtain, train, operate, and care for falcons, a staff of at least two full-time, well-trained personnel is required.

The use of trained dogs, especially border collies, to chase geese and other birds from golf courses, airports, and other sites is a recent development. As with falcons, the advantage is exposure to a natural predator. Likewise, the disadvantage is that the dog must be under the control of a trained person at all times, and the dog must be cared for and exercised 365 days a year. A dog will have little influence on birds that are flying over the airport.

9.2.C.IX RADIO-CONTROLLED MODEL AIRCRAFT TO REPEL BIRDS

Radio-controlled (RC) model aircraft, which provide both visual and auditory stimuli, occasionally have been used to harass birds on airports. One advantage is that the RC aircraft is under the control of a person and can be directed precisely to herd the birds away from the airport runway. A second advantage is that the RC aircraft can be deployed on an “as needed” basis with little maintenance needed between flights. Some RC aircraft have been designed to mimic the appearance of a falcon and even to remotely fire pyrotechnics. The disadvantage is that a trained person is required to operate the RC aircraft in an airport environment. Before using RC aircraft, ensure that the radio frequencies used are compatible with other radio uses in the airfield environment.

9.2.C.X NONLETHAL PROJECTILES TO REPEL BIRDS

Paint balls and rubber or plastic projectiles, fired from paint-ball guns and 12-gauge shotguns, respectively, can be used to reinforce other dispersal techniques employed to repel Canada geese, roosting vultures, and perhaps other species of birds. With paint balls, a high-quality paint-ball gun should be used to provide sufficient accuracy and velocity (typically fired from 20 to 100 feet from bird). There are several types of rubber or plastic projectiles (slugs, buck shot, pellets, beads) for use in a shotgun. The proper distance from the bird for firing varies by projectile and species of bird. Personnel using these techniques need to be trained in firearm use and in the use of the particular projectiles being deployed. The objective is to shoot from a sufficient distance so that the projectile induces temporary pain, but no injury, in the bird struck.

Birds of prey, such as this red-tailed hawk, are captured with bal-chatri traps at some USA airports and relocated 50-100 miles from the airport. Studies have shown that relocated juvenile hawks typically do not return to the airport. Adult territorial birds will often return (photo courtesy of L. Schafer, USDA).

9.2.D WILDLIFE REMOVAL TECHNIQUES

Habitat modification, exclusion, and repellent techniques are the first lines of action in any Wildlife Hazard Management Plan. However, these actions will not solve every problem; therefore, hazardous wildlife sometimes must be removed from an airport. Such removal can be accomplished by capturing and relocating or by killing the target animals. With few exceptions, a federal Migratory Bird Depredation Permit, and in many cases a state permit, is required before any migratory birds may be taken (captured or killed). A state permit is generally necessary before any state-protected birds or mammals may be taken. Any capturing or killing must be done humanely and only by people who are trained in wildlife species identification and the techniques to be deployed.

9.2.D.I CAPTURING BIRDS AND MAMMALS

The disposition of live-captured birds and mammals will depend on the legal, political, and social realities of each situation. State wildlife agencies are increasingly restrictive about the relocation of captured wild animals, particularly for common species, because of disease concerns and the creation of additional wildlife problems at release sites. When practical, euthanize unprotected birds, such as pigeons, house sparrows, and European starlings, using procedures recommended by the American Association of Wildlife Veterinarians (AAWV). Dispose of common mammals, such as raccoons, woodchucks, and coyotes, captured on airports by following state regulations. Resident Canada geese captured during molt or by nets can be euthanized and donated to soup kitchens or food banks, provided the necessary federal and state permits are in place.

9.2.D.I.A CHEMICAL CAPTURE OF BIRDS

Alpha Chloralose (A-C) is registered with the FDA as an immobilizing agent for use in capturing waterfowl, coots, and pigeons. A-C can only be used by people certified to use A-C working under the authority of personnel with the U.S. Department of Agriculture Wildlife Services (USDA/WS). A-C, incorporated into bread baits, is ideal for selectively capturing ducks, geese, and coots that can be hand-fed at urban ponds and parks. Corn baits are recommended for pigeons or groups of waterfowl or coots that cannot be individually baited. Birds ingesting a clinical dose of A-C can be captured in 30- to 90-minutes. Complete recovery normally occurs within 8 hours but can take up to 24 hours.

Cannon or rocket nets are well suited for capturing up to 100 or more waterfowl, pigeons, or gulls in situations where other methods might not be practical. The net must be placed where it can be safely discharged, and the target birds must be trained to feed in front of it. Depending on the situation, prebaiting can take several days. Here, white pelicans are being captured for banding to study migration patterns (photo by T. King, USDA).

9.2.D.I.B LIVE-TRAPPING BIRDS

The major advantage of live trapping is selectivity: any non-target birds can be released unharmed. The major disadvantage is that live trapping is often labor intensive. Traps must be tended frequently to remove captured animals and, in the case of cage traps with decoy birds, to provide food and water. Hygnstrom et al. (1994) provides detailed descriptions of various trap designs.

Trapping is used on some airports to remove raptors (hawks and owls) in the aircraft operating area. Bal-chatri, noose carpets, Swedish goshawk, or sliding padded pole traps are typically used. Because raptors are desirable components of bird communities, most permits for trapping raptors require that the birds be banded and relocated into suitable habitat at least 50 miles from the airport.

Live trapping, using walk-in type traps on roofs or other isolated sites, can be used to remove pigeons at airports. Euthanize captured pigeons following AAWV guidelines. If relocated, pigeons can fly long distances to return to the site of capture.

Net launchers use a blank rifle cartridge to propel a net. Fired from the shoulder much like a shotgun or rifle, net launchers can capture individual or small groups of problem birds that can be approached within about 50 feet.

9.2.D.I.C CHEMICAL CAPTURE OF MAMMALS

Large mammals, such as deer, can be captured with tranquilizer guns, but this is generally not a practical or desirable option for airports. Live capture and relocation of deer is not recommended or permitted in most states because deer populations are at or near carrying capacity. However, in those situations where the use of firearms is not safe or practical, the use of tranquilizer guns might be appropriate. The use of tranquilizer guns requires personnel with a high degree of skill and experience. If used in an airport environment, safeguards must be in place to ensure partially tranquilized deer do not enter runway areas.

9.2.D.I.D LIVE-TRAPPING MAMMALS

Specialized drop-door traps, drop nets, or rocket net set-ups can be used to live-capture deer, but live-capturing deer generally is not recommended for airport situations for reasons outlined above. However, smaller box-type or basket live-traps can be used to capture medium-sized mammals, such as raccoons, woodchucks, beavers, and feral dogs. Leg-hold traps and snares can be used to capture coyotes, feral dogs and raccoons.

Hunting during the regular deer season should be encouraged in areas adjacent to airports having deer problems to reduce the population in the general area. Archery hunting sometimes can be used in areas closed to firearms (photo by E. Cleary, FAA).

Successful mammal trapping, especially with leg-hold traps and snares, requires a high degree of skill and experience. Once set, traps must be checked frequently (at least once every 24 hours and more frequently in hot or cold weather). Trappers must be knowledgeable in procedures for handling and euthanizing mammals. State and local regulations might restrict the use of some types of traps.

9.2.D.II KILLING BIRDS AND MAMMALS

In general, killing of wildlife on an airport is the last option deployed after habitat modification, exclusion techniques, and repellent actions have been implemented. However, the management of a wildlife hazard situation on an airport might require killing a particular animal or require that a local population of a problem species be reduced by lethal means until a long-term, nonlethal solution is implemented (e.g., erection of deer-proof fence, relocation of nearby gull nesting colony). In addition, lethal control of a few individuals is sometimes necessary to reinforce nonlethal frightening techniques. Some lethal control is usually necessary as part of an integrated Wildlife Hazard Management Plan for an airport.

The following information must be developed to justify lethal control and to minimize adverse public reaction to a program involving killing:

- Documentation that the wildlife species is an economic, safety, or health threat.
- Justification of why nonlethal options are not adequate to solve the problem.
- An assessment of the impact that the killing will have on local and regional populations of the species (i.e., is the level of killing planned likely to result in a significant reduction in numbers of the species at the local or regional level?).
- Assurance that the killing procedure is appropriate (i.e., safe, effective, and humane) and specific for the target wildlife species.
- Documentation of the effectiveness of the killing program in helping to solve the problem (e.g., reduction in bird strikes).
- Recommended steps to be taken, if any are feasible, to reduce the need for killing in the future.

Canada geese should not be allowed to nest on airports. Nests and eggs should be destroyed after appropriate permits are obtained (photo courtesy of J. Bucknall, USDA).

9.2.D.II.A DESTROYING EGGS AND NESTS

Do not allow Canada geese, mute swans, and gulls to nest on airport property. Provided the correct permits are in place, destroy (break eggs and remove nest material) any goose, mute swan, or gull nests with eggs found on an airport. Egg addling (oiling, shaking, or puncturing), whereby the birds continue to incubate nonviable eggs, is not recommended for airports. Egg addling encourages the nesting birds (and any nonbreeding birds associated with them) to stay on the airport. At the time of nest destruction, harass the adult birds from the airport. Check the nesting area weekly for renesting until the end of the nesting season (generally the end of June). As an alternative to harassment, it may be better to shoot nesting geese and mute swans (see below).

Destroy pigeons, starlings, and house sparrows nests whenever they are encountered in airport buildings and structures. Where practical, install physical barriers, as discussed above, to prevent renesting.

Nests of other birds hazardous to aviation generally also should be destroyed when encountered on airports. Remember that migratory bird nests are protected by federal law and may not be taken without a Depredation Permit. Each situation will have to be addressed on a case-by-case basis, depending on the species of bird and level of threat posed, location from runways, bird movement patterns, and other factors.

9.2.D.II.B SHOOTING BIRDS

Shooting birds in an airport environment generally falls into two main categories. First, pigeons using hangers, bridge girders, and other sites can be shot at night with an air rifle. This nighttime shooting is done quietly and discretely, with the objective being to disturb the birds as little as possible so that the maximum number can be removed.

In the second category of shooting, common birds, such as gulls and geese, in the AOA that are not responding to various repellent methods can be shot with a 12-gauge shotgun. This shooting is done during daylight in the open so that other birds can witness the action. Shooting a shotgun has several effects on a flock of birds. First, it reinforces other audio or visual repelling techniques. Second, the loud noise, coupled with the death of one or more of the flock members, can frighten the rest of the flock away. Third, the target birds are permanently removed.

Compressed CO_2-powered pellet rifles, with laser pointers and telescopic sights, are an effective means of removing rock doves (pigeons) from hangers and other structures at airports. Personnel must be properly trained in the use of all pyrotechnic devices and firearms, and their use must be coordinated with airport security (photo by R. A. Dolbeer).

Four cardinal rules apply when using shooting as a control method at airports:

1. Use only personnel who are trained in the use of firearms and who have an excellent knowledge of wildlife identification.
2. Use the proper gun and ammunition for the situation.
3. Have necessary federal and state wildlife kill permits in place, and keep accurate records of birds killed by species and date.
4. Notify airport security, air traffic control, and, if appropriate, the local law enforcement authority before instituting a shooting program. Local ordinances against the discharge of firearms within certain distances of buildings, or within the city limits, may need to be waived.

9.2.D.II.C SHOOTING MAMMALS

Adopt a “zero tolerance” for deer on airports. If fencing is inadequate to keep deer off an airport or if deer have gotten inside the airport’s fence, shooting is the best procedure for removing the deer. Because of inherent safety considerations and to ensure safe and efficient removal, shooting on airports must be by professional sharpshooters, using non-ricocheting bullets in rifles equipped with night-vision scopes and noise suppressers. Elevated shooting stands can be erected on the ground or on a truck bed to direct shots toward the ground. When practical, donate the meat from deer that are removed from airports to charity. Shooting of deer on airports must be coordinated through the state wildlife agency.

Encourage hunting during the regular deer season in areas adjacent to airports with deer problems to reduce the population in the general area. Archery hunting sometimes can be used in areas closed to firearms.

9.2.D.II.D ORAL TOXICANTS FOR BIRDS

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

RESTRICTED USE PESTICIDE

For retail sale to and use only by Certified Applicators or persons under their direct supervision and only for those uses covered by the Certified Applicators certification.

ZINC PHOSPHIDE ON WHEAT

FOR MOUSE CONTROL

For the control of meadow voles, prairie voles, pine voles, mountain voles, and white-footed mice in ornamentals, orchards, vineyards, rangelands, forests, lawns, golf courses, parks, nurseries, and highway medians.

ACTIVE INGREDIENT:	
Zinc Phosphide	**1.82%**
INACTIVE INGREDIENTS:	**98.18%**
TOTAL	**100.00%**

This is the center portion of a zinc phosphide rodenticide label showing the restricted use statement, target species, and ingredients list. Other parts of the label provide important information such as the manufacturer, EPA registration number, and the directions for use. Always read the entire label before using any pesticide.

The use of toxic baits to kill target birds without affecting non-target species requires considerable skill and patience. Daily movement patterns of the target birds among feeding, loafing, and roosting sites must be determined so attractive bait sites that are controlled from public access (such as a roof top) can be selected. The proper bait (a highly desired food) must be selected, and the birds then must be prebaited, often for a week or more, to ensure good bait acceptance and that non-target animals are not visiting the bait site. Proper prebaiting is the most critical step of a successful program. During the baiting period, all uneaten bait must be removed daily. With DRC-1339, birds typically die 1 to 3 days after bait ingestion; therefore, areas surrounding bait sites will need to be searched for several days after baiting to remove dead birds.

9.2.D.II.E CONTACT TOXICANTS FOR BIRDS

Hollow metal perches containing a wick treated with the toxicant fenthion previously were used to control pigeons, house sparrows, and starlings in and around buildings. The USEPA has phased out the use of fenthion-treated perches because of concerns for secondary poisoning of raptors and mammalian scavengers feeding on dying birds. No replacement chemical has been registered at this time (2005).

If toxic perches become available, their use outside of buildings is not recommended because there is no way of preventing non-target birds from landing on them. Even when used inside buildings, careful placement of perches and monitoring must be done to ensure non-target birds such as swallows are not exposed to the toxicant. Pick up and properly dispose of all dead birds.

Anticoagulant rodenticides in covered bait stations are being used to control mice and voles in the AOA of this airport in Mexico. The bait stations are checked regularly and old, moldy bait is removed and properly disposed. This airport also uses falconry as part of its integrated program (photo by R. A, Dolbeer, USDA).

9.2.D.II.F Toxicants for Mammals

Small rodent populations (e.g., voles, house and deer mice, Norway rats) might erupt in grassy and brushy areas or around construction debris on airports, attracting raptors and creating a hazard to aviation. In general, control rodent populations by habitat management (mowing, sanitation, clean-up of brushy areas and piles of debris). However, there might be situations where the use of a rodenticide is appropriate to reduce rodent populations in airside vegetation. The control of commensal rodents in airport terminal buildings and other facilities will not be discussed here because these jobs are usually handled by private pest control operators.

There are two types of rodenticides that might be available for use in airside vegetation, anticoagulants and acute toxicants. Anticoagulants, of which there are several types registered, cause the rodent to die from internal bleeding. Some anticoagulants require multiple feedings to induce sufficient bleeding for death whereas others require only a single feeding. The only acute toxicant registered for above-ground treatment of field rodents is zinc phosphide, available in pellet and grain-bait formulations and as a concentrate for specialized bait formulations.

Depending on registration label instructions, rodenticide baits can be broadcast in the vegetation or hand-placed in burrows and runways. Anticoagulant baits can also be placed in various types of bait containers placed in areas of high rodent activity. Care must be taken to minimize non-target bird and mammal exposure with broadcast and hand-placed baits.

9.2.D.II.G FUMIGANTS FOR MAMMALS

Burrowing rodents on airports, such as woodchucks (ground hogs) and prairie dogs, can be killed by fumigation of burrows with either gas cartridges or aluminum phosphide tablets. Gas cartridges, ignited from a burning fuse after placement in the burrow, generate carbon monoxide. Aluminum phosphide pellets react with moisture in the burrow to produce phosphine gas. Care must be taken to plug all burrow entrances with sod after placement of the cartridge or pellets in the burrow. Gas cartridges are a general use, over-the-counter pesticide. Aluminum phosphide pellets can only be applied by certified pesticide applicators and might not be available in all states. As with all pesticides, it is critical to make sure the wildlife species you are treating is covered under the registration for your state.

Earthworms crawling onto runways after heavy rains can be a strong attractant to gulls and other birds. This runway in New Zealand uses slit drains to block worms from reaching the runway. Other options include brush-sweeping runway edges to remove worms and deploying extra personnel to disperse gulls. As of 2005, there are no chemicals registered in the USA to control earthworms (photo by R. A. Dolbeer, USDA).

9.2.D.II.H LETHAL TRAPS FOR MAMMALS

Depending on state and local laws, Conibear® (body gripping) traps can be used to remove woodchucks, beaver, and other medium-sized mammals that create problems on airports. Neck snares can be used to capture coyotes, beaver, and certain other mammals. The use of these lethal traps requires a high degree of skill and experience to selectively capture the target animal. Once set, traps must be checked frequently (at least once every 24 hours and more frequently in hot or cold weather) to euthanize any animals that might be captured but not killed. Trappers must be knowledgeable in procedures for handling and euthanizing captured mammals.

9.3 CONCLUSIONS

Habitat modifications to minimize food, cover, and water and physical barriers to exclude wildlife are the foundations of wildlife hazard management programs for airports. In addition, an integrated array of repellent techniques is necessary to disrupt normal behavior and to stress hazardous wildlife that attempt to use the airport. These repellent techniques must be used judiciously and backed by real threats to minimize habituation. To this end, lethal control of selected individuals of common species is sometimes necessary to reinforce repellent actions. Furthermore, the management of a wildlife hazard situation on an airport might require removal of a particular animal or group of animals or require that a local population of a problem species be reduced by lethal means until a long-term, nonlethal solution is implemented. Finally, the most critical factor for the success of a wildlife hazard management program is to have motivated and trained professionals who are knowledgeable about the wildlife species attempting to use the airport environment and the techniques used to manage the problems these species create.

The management of hazardous wildlife at airports often generates interest from the public and news media. Professional biologists and public relations personnel at airports must be prepared to explain and defend actions taken to protect the flying public from wildlife hazards to aviation (photo by R. A. Dolbeer, USDA).

9.4 OTHER SOURCES OF INFORMATION

For details on techniques, equipment, chemical registrations, species-specific management recommendations, and sources of supply, the reader is referred to—

Hygnstrom, S. C., R. M. Timm, and G. E. Larson, editors. 1994. *Prevention and control of wildlife damage*. University of Nebraska Cooperative Extension Division, Lincoln, Nebraska. (This 2-volume manual is also available online at ianrwww.unl.edu/wildlife/solutions/handbook/.)

In addition, Appendix L provides a list of research publications by the U.S. Department of Agriculture, National Wildlife Research Center (NWRC), documenting results of evaluations of various wildlife control products and strategies. These evaluations were conducted between 1992 and 2004 with support from the FAA under an interagency agreement with NWRC. This is not a complete list of all evaluations that have been done on all wildlife control methods, but it does provide information on many of the control methods discussed in this chapter.

Birds and aircraft will always share the skies, and there will always be the risk of collisions. To minimize that risk, airports must be managed to be as unattractive to birds as possible. Integrating various control strategies offers the maximum long-term effectiveness and immediate relief from a hazardous situation and minimizes the need for the use of lethal control methods (photo by B. Washburn, USDA).

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SELECTED PUBLICATIONS AND WEB SITES

In addition to these publications and web sites, a list of wildlife field guides and reference books is provided at the end of Chapter 8. Also, a list of publications on wildlife control techniques by the U.S. Department of Agriculture, National Wildlife Research Center, is provided in Appendix L.

Belant, J. L., S. K. Ickes, and T. W. Seamans. 1998. Importance of landfills to urban-nesting herring and ring-billed gulls. Landscape and Urban Planning 43:11-19.

Bellrose, F. C. 1980. Ducks, geese, and swans of North America, third edition. Stackpole Books, Harrisburg, Pennsylvania. 540 pages.

Blokpoel, H. 1974. Bird hazards to aircraft. Canadian Wildlife Service. Ministry of Supply and Services, Ottawa, Ontario, Canada. 236 pages.

Blokpoel, H., and, G. D. Tessier. 1984. Overhead wires and monofilament lines exclude ring-billed gulls from public places. Wildlife Society Bulletin 12:55-53

Cleary, E. C., R. A. Dolbeer, and S. E. Wright. 2004. Wildlife strikes to civil aircraft in the United States, 1990-2003. U.S. Department of Transportation, Federal Aviation Administration, Serial Report No. 10, DOT/FAA/AS/00-6(AAS-310). Washington DC USA. 56 pages. (http://wildlife-mitigation.tc.faa.gov/).

Code of Federal Regulations (CFR): available at http://www.gpoaccess.gov/cfr/index.html

CFR Title 40, Part 258, Criteria for Municipal Solid Waste Landfills, section 258.10, Airport Safety, pages 395-396 (July 2003).

CFR Title 50, Parts 1-100, Wildlife and Fisheries, 494 pages (October 2003).

CFR Title 14, Part 139, Certification and Operations: Land Airports Serving Certain Air Carriers, section 139.337, Wildlife Hazard Management, pages 846-847 (June 2004).

Dolbeer, R. A., J. L. Belant, and J. L. Sillings. 1993. Shooting gulls reduces strikes with aircraft at John F. Kennedy International Airport. Wildlife Society Bulletin 21:442-450.

Dolbeer, R. A., S. E. Wright, and E. C. Cleary. 2000. Ranking the hazard level of wildlife species to aviation. Wildlife Society Bulletin 28:372-378 (updated in special report to Federal Aviation Administration in 2003 that was incorporated into AC 150/5200-7 [Appendix C].

Dolbeer, R. A., and P. Eschenfelder. 2002. Population increases of large birds, airworthiness standards, and high-speed flight: a precarious combination. Pages 273-281 in Proceedings of the 55th International Air Safety Seminar, Dublin, Ireland (Flight Safety Foundation, Alexandria, Virginia).

Dunning, J. B. Jr., editor. 1993. CRC Handbook of Avian Body Masses. CRC Press. Boca Raton, Florida. 371 pages. (Body weights for birds throughout the world)

Gill, F. B. 1990. Ornithology. W. H. Freeman and Company. New York, New York. 660 pages.

Hygnstrom, S. C., R. M. Timm, and G. E. Larson, *editors.* 1994. *Prevention and control of wildlife damage*. University of Nebraska Cooperative Extension Division, Lincoln, Nebraska. (This 2-volume manual is also available online at: ianrwww.unl.edu/wildlife/solutions/handbook/)

Knittle, C. E., and R. D. Porter, 1993. Waterfowl damage and control methods in ripening grain: an overview, US Fish and Wildlife Service, Fish and Wildlife Technical Report 14, Washington, DC. 17 pages.

Linnell, M. A., M. R. Conover, and T. J. Ohashi. 1999. Biases in bird strike statistics based on pilot reports. Journal of Wildlife Management 63:997-1003.

MacKinnon, B., R. Sowden, and S. Dudley (Editors). 2001. Sharing the skies: an aviation guide to the management of wildlife hazards. Transport Canada, Aviation Publishing Division, Tower C, 330 Sparks Street, Ottawa, Ontario, K1A 0N8 Canada. 316 pages.

Seubert, J. L. 1994. Assessing the implementation of wildlife hazard management programs at civil airports. Proceedings Bird Strike Committee Europe 22:275-284.

Smith, A. E., S. R. Craven, and P. D. Curtis. 1999. Managing Canada geese in urban environments. Jack Berryman Institute Publication 16, and Cornell Cooperative Extension, Ithaca, New York.

Transport Canada. 2002. Wildlife Control Procedures Manual. Safety and Security, Aerodrome Safety Branch. TP11500E. Ottawa, Ontario. (www.tc.gc.ca/civilaviation/aerodrome/wildlifecontrol/)

Web Sites:

Bird Strike Committee Canada. www.birdstrikecanada.com/

Bird Strike Committee USA. www.birdstrike.org/

Prevention and control of wildlife damage (2-volume manual). University of Nebraska Cooperative Extension Division, Lincoln, Nebraska. ianrwww.unl.edu/wildlife/solutions/handbook/

Transport Canada. www.tc.gc.ca/civilaviation/aerodrome/wildlifecontrol/

U.S. Department of Agriculture, Animal and Plant Health Inspection Service, Wildlife Services. www.aphis.gov.usda.gov/ws

U.S. Department of Defense, U.S. Air Force Bird Aircraft Strike Hazard (BASH) Team. http://afsafety.af.mil/afsc/bash/home.html.

U.S. Department of Interior, Fish and Wildlife Service. www.fws.gov/

U.S. Department of Transportation, Federal Aviation Administration, Airports Division. www.faa.gov/arp/.

U.S. Department of Transportation, Federal Aviation Administration, Wildlife Mitigation and Wildlife Strike Database. http://wildlife-mitigation.tc.faa.gov/.

Wright, S. E., R. A. Dolbeer, and A. J. Montoney. 1998. Deer on airports: an accident waiting to happen. Vertebrate Pest Conference 18:90-95.

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GLOSSARY

Air carrier. A person who holds or who is required to hold an air carrier operating certificate issued under this chapter [Title 14 Code of Federal Regulations, Part 139, Certification and Operation: Land Airports Serving Certain Air Carriers] while operating aircraft having a seating capacity of more than 10 passengers (14 CFR 139.5).

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

Air carrier operation. The takeoff or landing of an air carrier aircraft and includes the period of time from 15 minutes before until 15 minutes after the takeoff or landing (14 CFR 139.5).

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

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

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

Airport Operating Certificate. A certificate, issued under this part [Title 14 Code of Federal Regulations, Part 139, Certification and Operation: Land Airports Serving Certain Air Carriers], for operation of a Class I, II, III, or IV airport.

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

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

Bird hazard. See Wildlife hazard.

Bird strike. See Wildlife strike

Carrying capacity. The maximum number of animals of a given species, which a habitat is capable of supporting on a sustained basis. The goal of wildlife management programs on airports is to eliminate or minimize the carrying capacity of habitat for species hazardous to aviation.

Categorical exclusion (NEPA): A category of actions that do not individually or cumulatively have a significant effect on the human environment (40 CFR, 1508.4).

Certificate holder. The holder of an Airport Operating Certificate issued under this part. [Title 14 Code of Federal Regulations, Part 139, Certification and Operation: Land Airports Serving Certain Air Carriers] (14 CFR 139.5).

Class I airport. An airport certificated to serve scheduled operations of large air carrier aircraft that can also serve unscheduled passenger operations of large air carrier aircraft and/or scheduled operations of small air carrier aircraft.

Class II airport. An airport certificated to serve scheduled operations of small air carrier aircraft and the unscheduled passenger operations of large air carrier aircraft. A Class II airport cannot serve scheduled large air carrier aircraft.

Class III airport. An airport certificated to serve scheduled operations of small air carrier aircraft. A Class III airport cannot serve scheduled or unscheduled large air carrier aircraft.

Class IV airport. An airport certificated to serve unscheduled passenger operations of large air carrier aircraft. A Class IV airport cannot serve scheduled large or small air carrier aircraft.

Concurrent use. Aeronautical property used for compatible non-aviation purposes while at the same time serving the primary purpose for which it was acquired; and the use is clearly beneficial to the airport. The concurrent use should generate revenue to be used for airport purposes (see Order 5190.6A, *Airport Compliance Requirements*, sect. 5h).

Construct a new MSWLF. To begin to excavate, grade land, or raise structures to prepare a municipal solid waste landfill as permitted by the appropriate regulatory or permitting agency.

Cover. Vegetation covering a ground surface and serving as shelter for wildlife that are roosting, resting, nesting, or feeding.

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

Detention ponds. Storm water management ponds that hold storm water for short periods of time, generally less than then 48 hours (compare with retentions ponds).

Dump. The actively used and unvegetated part of an area where refuse (garbage) is placed and allowed to accumulate on the ground surface without periodic covering or compacting. This includes both authorized and unauthorized areas.

Establish a new Municipal Solid Waste Landfill. When the first load of putrescible waste is received on-site for placement in a prepared municipal solid waste landfill.

Extraordinary circumstances: Environmental conditions associated with an action that is normally categorically excluded and that: (1) involves one or more of the circumstances listed in FAA Order 1050.1E, paragraph 304a through 304k; and may cause a significant environmental effect.

Fly ash. The fine, sand-like residue resulting from the complete incineration of an organic fuel source. Fly ash typically results from the combustion of coal or organic waste used to operate a power generating plant.

Hazardous wildlife. Species of wildlife (birds, mammals, reptiles, insects, earth worms), including feral animals and domesticated animals not under control, that are associated with aircraft strike problems, are capable of causing structural damage to airport facilities, or act as attractants to other wildlife that pose a strike hazard (Advisory Circular 150/5200-33A – Hazardous Wildlife Attractants on or Near Airports; 14 CFR 139.3)

Heliport. An airport or an area of an airport used or intended to be used for the landing and takeoff of helicopters (14 CFR 139.3).

Mammal strike. See Wildlife strike.

Migratory Bird. "[A] migratory bird [is] … any bird whatever its origin and whether or not raised in captivity, which belongs to a species listed in Section 10.13 [of 50 CFR] or which is a mutation or a hybrid of any such species, including any part, nest, or egg of any such bird, or any product, whether or not manufactured, which consist, or is composed in whole or part, of any such bird, or any part, nest, or egg thereof." (50 CFR 10.12). This list includes almost all native bird species in the United States, with the exception of nonmigratory game birds such as pheasants, turkeys and grouse. Exotic and feral species such as graylag geese, muscovy ducks, European starlings, house (English) sparrows, and rock doves (pigeons) also are not listed in 50 CFR 10.13 and are therefore not protected by federal law.

Migration. The periodic movement of a wildlife species from one geographic area to another, usually in correlation with seasonal changes in weather.

Municipal Solid Waste Landfill (MSWLF). A publicly or privately owned discrete area of land or an excavation that receives household waste and that is not a land application unit, surface impoundment, injection well, or waste pile, as those terms are defined under 40 CFR § 257.2. An MSWLF may receive other types wastes, such as commercial solid waste, non-hazardous sludge, small-quantity generator waste, and industrial solid waste, as defined under 40 CFR § 258.2. An MSWLF can consist of either a stand alone unit or several cells that receive household waste.

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

New MSWLF. A municipal solid waste landfill that was established or constructed after April 5, 2001 (AC 150/5200-34).

Pesticide. (1) Any substance or mixture of substances intended for preventing, destroying, repelling, or mitigating any pest, (2) any substance or mixture of substances intended for use as a plant regulator, defoliant, or desiccant, and (3) any nitrogen stabilizer (7 U.S.C.A. 136[u]).

Piston-powered aircraft. Fixed-wing aircraft powered by piston engines. Such aircraft normally use LL-100 fuel.

Piston-use airport. Any airport that does not sell Jet-A fuel for fixed-wing turbine-powered aircraft, and primarily serves fixed-wing, piston-powered aircraft. Incidental use of the airport by turbine-powered, fixed-wing aircraft would not affect this designation. However, such aircraft should not be based at the airport (AC 150/5200-33A).

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

Putrescible waste. Solid waste that contains organic matter capable of being decomposed by micro-organisms and of such a character and proportion as to be capable of attracting or providing food for birds (40 CFR §257.3-8).

Putrescible-waste disposal operation. Landfills, garbage dumps, underwater waste discharges, or similar facilities where activities include processing, burying, storing, or otherwise disposing of putrescible material, trash, and refuse.

Propane cannon/exploder. A hollow cylinder that produces a loud explosion to frighten wildlife by the ignition of a metered amount of propane at timed or random intervals or by remote control.

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

Retention ponds. Storm water management ponds that hold water for long periods of time, generally more then 48 hours (compare with detentions ponds).

Runway protection zone (RPZ). An area off the runway end to enhance the protection of people and property on the ground (see AC 150/5300-13). The dimensions of this zone vary with the airport design, aircraft, type of operation, and visibility minimum.

Scheduled operation. Any common carriage passenger-carrying operation for compensation or hire conducted by an air carrier for which the air carrier or its representatives offers in advance the departure location, departure time, and arrival location. It does not include any operation that is conducted as a supplemental operation under 14 CFR part 121 or public charter operations under 14 CFR part 380.

Sewage sludge. Any solid, semi-solid, or liquid residue generated during the treatment of domestic sewage in a treatment works. Sewage sludge includes, but is not limited to, domestic septage; scum or solids removed in primary, secondary, or advanced wastewater treatment process; and a material derived from sewage sludge. Sewage does not include ash generated during the firing of sewage sludge in a sewage sludge incinerator or grit and screenings generated during preliminary treatment of domestic sewage in a treatment works (40 CFR 257.2). Also, the de-watered effluent resulting from secondary or tertiary treatment of municipal sewage and/or industrial wastes, including sewage sludge as referenced in USEPA's *Effluent Guidelines and Standards*, 40 CFR Part 401.

Sludge. Any solid, semi-solid, or liquid waste generated form a municipal, commercial or industrial wastewater treatment plant, water supply treatment plant, or air pollution control facility or any other such waste having similar characteristics and effect (40 CFR 257.2).

Solid waste. Any garbage, refuse, sludge, from a waste treatment plant, water supply treatment plant or air pollution control facility and other discarded material, including, solid liquid, semisolid, or contained gaseous material resulting from industrial, commercial, mining, and agricultural operations, and from community activities, but does not include solid or dissolved materials in domestic sewage, or solid or dissolved material in irrigation return flows or industrial discharges which are point sources subject to permits under section 402 of the Federal Water Pollution Control Act, as amended (86 Stat. 880), or source, special nuclear, or by product material as defined by the Atomic Energy Act of 1954, as amended (68 Statute 923), (40 CFR 257.2).

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

Turbine-powered aircraft. Aircraft powered by turbine engines including turbojets and turboprops but excluding turbo-shaft, rotary-wing aircraft. Such aircraft normally use Jet-A fuel (AC 150/5200-33A).

Turbine-use airport. Any airport that sells Jet-A fuel for fixed-wing turbine-powered aircraft.

Wastewater treatment facility. Any devices or systems used to store, treat, recycle, or reclaim municipal sewage or liquid industrial wastes, including Publicly Owned Treatment Works (POTW), as defined by Section 212 of the Federal Water Pollution Control Act (P.L. 92-500) as amended by the Clean Water Act of 1977 (P.L. 95-576) and the Water Quality Act of 1937 (P.L. 100-4). This definition includes any pretreatment involving the reduction of the amount of pollutants, the elimination of pollutants, or the alteration of the nature of pollutant properties in wastewater prior to or in lieu of discharging or otherwise introducing such pollutants into a POTW (40 CFR 403.3 [o], [p], [q]).

Wildlife. Any wild animal, including without limitation any wild mammal, bird, reptile, fish, amphibian, mollusk, crustacean, arthropod, coelenterate, or other invertebrate, including any part, product, egg, or offspring thereof (50 CFR 10.12, *Taking, Possession, Transportation, Sale, Purchase, Barter, Exportation, and Importation of Wildlife and Plants*). As used in this manual wildlife includes feral animals and domestic animals out of the control of their owners (14 CFR Part 139, Certification of Airports).

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

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

Wildlife strike. A wildlife strike has occurred when:

1. A pilot reports striking 1 or more birds or other wildlife;

2. Aircraft maintenance personnel identify aircraft damage as having been caused by a wildlife strike;

3. Personnel on the ground report seeing an aircraft strike 1 or more birds or other wildlife;

4. Bird or other wildlife remains, whether in whole or in part are found within 200 feet of a runway centerline, unless another reason for the animal's death is identified;

5. The animal's presence on the airport had a significant negative effect on a flight (i.e., aborted takeoff, aborted landing, high-speed emergency stop, aircraft left pavement area to avoid collision with animal) (criteria 1-4 adopted from Transport Canada (MacKinnon et al. 2001).

ACRONYMS

AAWV	American Association of Wildlife Veterinarians
AC	Advisory Circular
A-C	Alpha-Chloralose
ADC	Animal Damage Control (former name of USDA/WS)
AGL	Above Ground Level
AOA	Air Operations Area
APHIS	Animal and Plant Health Inspection Service
ATC	Air Traffic Control
BASH	Bird Aircraft Strike Hazard (USAF)
BSCC	Bird Strike Committee Canada
BSC-USA	Bird Strike Committee USA
C&D Landfills	Construction and Demolition Landfills
CFR	Code of Federal Regulations
EA	Environmental Assessment
EIS	Environmental Impact Statement
FAA	Federal Aviation Administration
FDA	Food and Drug Administration
FIFRA	Federal Insecticide, Fungicide, and Rodenticide Act
FOD	Foreign Object Debris, Foreign Object Damage
MBTA	Migratory Bird Treaty Act
MOA	Memorandum of Agreement
MOU	Memorandum of Understanding

MSWLF	Municipal Solid Waste Landfill
NEPA	National Environmental Policy Act
NIPAS	National Integrated Plan of Airport System
NWRC	National Wildlife Research Center (USDA)
OFA	Object Free Area
OFZ	Obstacle Free Zone
RPZ	Runway Protection Zone
TSS	Threshold Siting Service
USAF	United States Air Force
USCOE	United States Army Corps of Engineers
USDOD	United States Department of Defense
USDA/WS	United States Department of Agriculture, Wildlife Services
USDOT	United States Department of Transportation
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
WCP	Wildlife Control Personnel
WHA	Wildlife Hazard Assessment
WHMP	Wildlife Hazard Management Plan
WHWG	Wildlife Hazard Working Group
WS	Wildlife Services (USDA)

APPENDICES

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APPENDIX A:
Names, Addresses, and Phone Numbers:

(Correct as of 11 July 2004.)

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Ed Dorsett, AEA, ASO	AAS-300	202-267-8792
Ken Gilliam, Fire Safety Specialist	AAS-300 @ ORL/ADO	407-812-6331 ext. 134 Fax: 407-812-6978
Elizabeth Matarese, AAL, AWP	AAS-300	202-267-8723
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Dave Wahto	AAL-605	907-271-3815
Maverick Douglas, Lead Inspector	AAL-604	907-271-5444
Stephen Powell	AAL-624	907-271-5448
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Vincent Cimino, Lead Inspector	AEA-620	718-553-3348
Dennis O'Donnell	AEA-620	718-553-3343
John Green	AEA-620	718-553-3342
Guillermo Felix	AEA-620	718-553-3345
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		Fax: 718-995-5615
FAA Great Lakes Region Headquarters Airports Division O'Hare Lake Office Center 2300 East Devon Avenue Des Plaines, IL 60018 Serving: IL, IN, MI, MN, OH, ND, SD, WI		
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Jesse Carriger	AGL-621.7	847-294-7626
Ignacio Flores	AGL-621.5	847-294-7531
Birkely Rhodes,	AGL-621.3	847-294-7509
Kenneth Taira	AGL-621.2	847-294-7519
		Fax: 847-294-8088
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Patrick Rogers	ASO-620.K	404-305-6716
Randy Moseng	ASO-620.R	404-305-6714
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Ray Cavole	SFO-677	650-876-2778 ext 677
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Honolulu, HI Office		
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USDA APHIS Wildlife Services

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U.S. Department of Agriculture Animal and Plant Health Inspection Service Wildlife Services **Room 1624 South Agriculture Building** Washington, DC 20250-3402			
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Iowa	See Missouri		
Kentucky	See Tennessee		
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Massachusetts	Monte Chandler State Director	463 West Street Amherst, MA 01002	(413) 253-2403 FAX: (413) 253-7577
Michigan	Peter Butchko State Director	2803 Jolly Rd, Ste.160 Okemos, MI 48864	(517) 336-1928 FAX: (517) 336-1934
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Missouri	Ed Hartin State Director	1714 Commerce Court, Suite C Columbia, MO 65202	(573) 449-3033 FAX: (573) 449-4382
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New Jersey	Janet Bucknall State Director	140-C Locust Grove Rd. Pittstown, NJ 08867	(908) 735-5654 (908) 735-4513 FAX: (908) 735-0821
New York	Richard Chipman State Director	1930 Route 9 Castleton, NY 12033	(518) 477-4837 FAX: (518) 477-4899
North Carolina	Jon Heisterberg State Director	6213-E. Angus Dr. Raleigh, NC 27617	(919) 786-4480 ext. 228 FAX: (919) 782-4159
Ohio	Andy Montoney State Director	6929 Americana Pkwy. Reynoldsburg, OH 43068	(614) 892-2514 FAX: (614) 892-2519

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Tennessee	Brett Dunlap State Director	537 Myatt Dr. Madison, TN 37115	(615) 736-5506 FAX: (615) 736-2768
Vermont	See New Hampshire		
Virgin Islands	See Alabama		
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Wyoming	R.F. Krischke State Director	P.O. Box 59 Casper, WY 82602	(307) 261-5336 FAX: (307) 261-5996

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Utah	John Shivik Project Leader	USDA/NWRC Room 163, BNR Bldg. Utah State University Logan, UT 84322	(435) 797-2505 FAX (435) 797-0288
Washington	Vacant	USDA/NWRC 9730-B Lathrop Industrial Drive SW Olympia, WA 98512	(360) 956-3793 FAX (360) 956-3925
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Ohio	Bob Beason Project Leader	USDA/NWRC 6100 Columbus Ave. Sandusky, OH 44870	(419) 625-0242 FAX (419) 625-8465
Pennsylvania	Vacant	USDA/NWRC c/o Monell Chemical Senses Center 3500 Market St. Phil., PA 19104	(215) 898-5753 FAX (215) 898-2084

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APPENDIX B:
Animal Damage Control Act,
2 March 1931, as amended

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ANIMAL DAMAGE CONTROL ACT

7 U.S.C. §§ 426-426c, 2 March 1931, as amended 1937 and 1991.

Overview. This Act gives the Secretary of Agriculture broad authority to investigate and control certain predatory or wild animals and nuisance mammal and bird species.

Animal Damage Control. The Secretary is authorized to conduct investigations, experiments, and tests to determine the best methods of eradication, suppression, or bringing under control mountain lions, wolves, coyotes, bobcats, prairie dogs, gophers, ground squirrels, jack rabbits, brown tree snakes, and other animals injurious to agriculture, horticulture, forestry, animal husbandry, wild game animals, fur-bearing animals and birds. Another purpose of these investigations is to protect stock and other domestic animals through the suppression of rabies and tularemia in predatory or other wild animals. The Secretary is also directed to conduct campaigns for the destruction or control of these animals. In carrying out the Act, the Secretary may cooperate with states, individuals, agencies and organizations. § 426.

The Secretary is also authorized, except for urban rodent control, to control nuisance mammals and birds and those mammal and bird species that are reservoirs for zoonotic diseases. Agreements may be entered into with states, local jurisdictions, individuals, and organizations for this purpose. § 426c.

Brown Tree Snakes. Section 1013 of Public Law 102-237, which amended the Act in 1991, also requires the Secretary to initiate a program to prevent the inadvertent introduction of the brown tree snake into Hawaii from Guam. The Secretary also is required, to the extent practicable, to take action to prevent the inadvertent introduction of the brown tree snake into other areas of the U.S. from Guam. Public Law 102-190 requires the Secretary of Defense to take action to prevent its introduction by Department of Defense aircraft or vessels. §426 note.

Appropriations Authorized. Congress authorized the Secretary to make expenditures for equipment, supplies, and materials, including the employment of persons to carry out this Act. § 426b.

Historical Note. Public Law 99-190, approved in 1935, transferred administration of the Act from the Secretary of Agriculture to the Secretary of the Interior. In 1986 administration of the Act was transferred back to the Secretary of Agriculture.

Ruth Musgraves, et al, Federal Wildlife & Related Laws Handbook, US Fish and Wildlife Service, Chapter 4 - Statute Summaries. Center for Wildlife Law.

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APPENDIX C:
FAA Advisory Circulars

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AC 150/5200-32A Reporting Wildlife Aircraft Strikes

U.S. Department of Transportation **Federal Aviation Administration**	**Advisory Circular**	
Subject: REPORTING WILDLIFE AIRCRAFT STRIKES	**Date:** 12/22/04 **Initiated by:** AAS-300	**AC No:** 150/5200-32A **Change:**

1. PURPOSE:

This Advisory Circular (AC) explains the importance of reporting collisions between aircraft and wildlife, more commonly referred to as wildlife strikes. It also examines recent improvements in the Federal Aviation Administration's (FAA) Bird/Other Wildlife Strike Reporting system; how to report a wildlife strike; what happens to the wildlife strike report data; how to access the FAA National Wildlife Aircraft Strike Database; and the FAA's Feather Identification program.

2. BACKGROUND:

The FAA has long recognized the threat to aviation safety posed by wildlife strikes. Worldwide, wildlife strikes cost civil aviation an estimated $1.2 billion annually. Each year in the U.S., wildlife strikes to U.S. civil aircraft cause about $500 million in damage to aircraft and about 500,000 hours of civil aircraft down time. For the period 1990—2004, over 63,000 wildlife strikes were reported to the FAA. About 97 percent of all wildlife strikes reported to the FAA involve birds, almost 3 percent involve mammals and less than 1 percent involved reptiles. Waterfowl (ducks and geese), gulls, and raptors (mainly hawks and vultures) are the bird species that cause the most damage to civil aircraft in the United States. Vultures and waterfowl cause the most losses to U.S. military aircraft.

The FAA has initiated several programs to address this important safety issue, including the collection, analysis, and dissemination of wildlife strike data. The FAA actively encourages the voluntary reporting wildlife strikes.

3. HOW TO REPORT A WILDLIFE AIRCRAFT STRIKE:

A wildlife strike has occurred when:

1. A pilot reports striking 1 or more birds or other wildlife

Aircraft maintenance personnel identify aircraft damage as having been caused by a wildlife strike;

2. Personnel on the ground report seeing an aircraft strike 1 or more birds or other wildlife;
3. Bird or other wildlife remains, whether in whole or in part, are found within 200 feet of a runway centerline, unless another reason for the animal's death is identified; and
4. An animal's presence on the airport had a significant negative effect on a flight (i.e., aborted takeoff, aborted landing, high-speed emergency stop, aircraft left pavement area to avoid collision with animal) (Transport Canada, Airports Group, *Wildlife Control Procedures Manual*, Technical Publication 11500E, 1994).

Pilots, airport operations, aircraft maintenance personnel, or anyone else who has knowledge of a strike is encouraged to report it to the FAA. Wildlife strikes may be reported to the FAA using the paper FAA Form 5200-7 Bird/Other Wildlife Strike Report, or electronically at the *Airport Wildlife Hazard Mitigation* web site: http://wildlife-mitgation.tc.faa.gov. The FAA's Bird/Other Wildlife Strike Report Form can be downloaded or printed from the same web site. Paper copies of Form 5200-7 may also be obtained from the Airports District Offices (ADO's), Flight Standards District Offices (FSDO's), and Flight Service Stations (FSS). Copies of the Bird/Other Wildlife Strike Report form are also found in the Airman's Information Manual (AIM).

Paper forms are pre-addressed to the FAA. No postage is needed if the form is mailed in the United States. It is important to include as much information as possible on the strike report.

The FAA National Wildlife Strike Database Manager edits all strike reports to insure consistent, error-free data before entering the report into the Database. This information is supplemented with non-duplicated strike reports from other sources. About every 6 weeks, an updated version of the Database is posted on the web site. Annually, a current version of the Database is forwarded to the International Civil Aviation Organization (ICAO) for incorporation into ICAO's Bird Strike Information System Database.

Analyses of data from the FAA National Wildlife Aircraft Strike Database has proved invaluable in determining the nature and severity of the wildlife strike problem. The Database provides a scientific basis for identifying risk factors; justifying, implementing and defending corrective actions at airports; and for judging the effectiveness of those corrective actions. The Database is invaluable to engine manufacturers and aeronautical engineers as they develop new technologies for the aviation industry. Each wildlife strike report contributes to the accuracy of and effectiveness of the Database. Moreover, each report contributes to the common goal of increasing aviation safety.

4. ACCESS TO THE FAA NATIONAL WILDLIFE AIRCRAFT STRIKE DATABASE:

In order to expedite the dissemination of this important information, the FAA has developed procedures for searching the Database on line at: http://wildlife-mitigation.tc.faa.gov. The public may access the Database without a password and retrieve basic information on the number of strikes by year, by state, and by species of wildlife.

Access for airport operators, airline operators, engine manufactures, air frame manufactures, and certain other governmental agencies requires a password to access the Database and allows retrieval of more detailed wildlife strike information for their specific area of concern. An airport operator's access is limited to strike information for incidents occurring on its particular airport. Airlines may only access strike records involving aircraft owned or operated by them. Comparisons among individual airports and airlines are not made.

Airline and airport operators, airframe and engine manufactures, or governmental agencies may gain access the FAA National Wildlife Aircraft Strike Database by writing the FAA Staff Wildlife Biologist. All written requests should follow the guidelines provided below:

1. On Company Letterhead, request access to the FAA National Wildlife Aircraft Strike Database. Include:
    a. Your preferred password. (The FAA does not assign passwords. The password should be no more than 8 characters, alphanumeric, and case sensitive.)
    b. Your contact information. (Title, mailing address, phone number, and e-mail address.)
2. Submit the request to:

   FAA Staff Wildlife Biologist, AAS-300
   Federal Aviation Administration,
   800 Independence Ave. SW.
   Washington, DC. 20591.
3. When the FAA receives the request for access to the Database, the request and the password will be entered into the system. Upon completion of the process, the requestor will be notified by e-mail.

The Database is accessible from the *Airport Wildlife Hazard Mitigation* web page (http://wildlife-mitigation.tc.faa.gov):

5. BIRD IDENTIFICATION:

Accurate species identification is critical for bird-aircraft strike reduction programs. Wildlife biologist must know what species of animal they are dealing with in order to make proper management decisions. The FAA, the U.S. Air Force, and the U.S. Department of Agriculture – Wildlife Services are working closely with the Feather Identification Lab at the Smithsonian Institution, Museum of Natural History, to improve the understanding and prevention of bird-aircraft strike hazards. Bird strike remains that cannot be identified by airport personnel or by a local biologist can be sent (with FAA Form 5200-7) to the Smithsonian Museum for identification.

Feather identification of birds involved in bird-aircraft strikes will be provided free of charge to all U.S. airport operators, all U.S. aircraft owners/operators (regardless of where the strike happened), or to any foreign air carrier if the strike occurred at a U.S. airport.

Please observe the following guidelines for collecting and submitting feather or other bird/wildlife remains for species identification. These guidelines help maintain species identification accuracy, reduce turn-around time, and maintain a comprehensive FAA National Wildlife Aircraft Strike Database.

1. Collect and submit remains as soon as possible.
2. Provide complete information regarding the incident
    a. Fill out FAA Form 5200-7 – Bird/Other Wildlife Strike Report.
        i. A copy of Form 5200-7 can be downloaded and or printed from: http://wildlife-mitigation.tc.faa.gov.
    b. Mail report with feather material (see address below).
    c. Provide your contact information if you wish to be informed of the species identification.
3. Collect as much material as possible in a clean plastic/ziplock bag. (Please, do not send whole birds).
    a. Pluck/pick a variety of feathers from the wings, tail and body.
    b. **Do not** cut off feathers. This removes the downy region we may need to aid in identification.
    c. Include any feathers with distinct colors or patterns.
    d. Include any downy “fluff”.
    e. Include beaks, feet, and talons if possible.
    f. Where only a small amount of material is available, such as scrapings from an engine or smears on wings or windshields, send all of it.
    g. **Do not** use any sticky substance such as tape or post-it notes to attach feathers.
4. Mail the Bird/Other Wildlife Strike Report and collected material to the Smithsonian’s Feather Identification Lab. They will forward the report to the FAA Staff Wildlife Biologist at the FAA’s Office of Airport Safety and Standards.

For Material Sent via Express Mail Service:	For Material Sent via US Postal Service:
Feather Identification Lab Smithsonian Institution NHB, E610, MRC 116 10th & Constitution Ave. NW Washington, D.C. 20560-0116	Feather Identification Lab Smithsonian Institution PO Box 37012 NHB, E610, MRC 116 Washington, D.C. 20013-7012
(This can be identified as “safety investigation material”)	(Not recommended for priority cases.)

The species identification turn around time is usually 24 hours from receipt. Once processed, the reports and species identification information are sent to the Database Manager for entry into the FAA National Wildlife Aircraft Strike Database. Persons wishing to be notified of the species identification must include contact information (e-mail, phone, etc.) on the report.

For more information contact The FAA Staff Wildlife Biologist [(202) 267-3389], or the Smithsonian’s Feather Identification Lab [(202) 633-0801].

J. R. White

For David L. Bennett

Director of airports Safety and standards

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AC 150/5200-33A Hazardous Wildlife Attractants On Or Near Airports

U.S. Department of Transportation **Federal Aviation Administration**	**Advisory Circular**

Subject: HAZARDOUS WILDLIFE ATTRACTANTS ON OR NEAR AIRPORTS	**Date:** July 27, 2004 **Initiated by**: AAS-300	**AC No**: 150/5200-33A **Change**:

1. PURPOSE. This Advisory Circular (AC) provides guidance on certain land uses that have the potential to attract hazardous wildlife on or near public-use airports. It also discusses airport development projects (including airport construction, expansion, and renovation) affecting aircraft movement near hazardous wildlife attractants. Appendix 1 provides definitions of terms used in this AC.

2. APPLICABILITY. The Federal Aviation Administration (FAA) recommends that public-use airport operators implement the standards and practices contained in this AC. The holders of Airport Operating Certificates issued under Title 14, Code of Federal Regulations (CFR), Part 139, Certification of Airports, Subpart D (Part 139), may use the standards, practices, and recommendations contained in this AC to comply with the wildlife hazard management requirements of Part 139. Airports that have received Federal grant-in-aid assistance must use these standards. The FAA also recommends the guidance in this AC for land-use planners, operators of non-certificated airports, and developers of projects, facilities, and activities on or near airports.

3. CANCELLATION. This AC cancels AC 150/5200-33, *Hazardous Wildlife Attractants on or near Airports*, dated May 1, 1997.

4. PRINCIPAL CHANGES. This AC contains the following major changes:

a. Reorganized outline of the AC.

b. Expanded Table 1 to include updated information from the Special Report for the FAA, “Ranking the Hazard Level of Wildlife Species to Civil Aviation in the USA: Update #1, July 2, 2003”.

c. Removed Table 2, which outlined the distances between certain airport features and any on-airport agricultural crops, and relocated the discussion of on-airport agricultural activities to Paragraph 2-6.

d. Added text about the basis for separation distances between wildlife hazards and airport movement areas and added Figure 1 depicting the separation distances.

e. Added options for wetland mitigation for impacts from airport projects, including mitigation banking.

f. Further recognized the importance of the Wildlife Hazard Management Plan (WHMP).

5. BACKGROUND. Information about the risks posed to aircraft by certain wildlife species has increased a great deal in recent years. Improved reporting, studies, documentation, and statistics clearly show that aircraft collisions with birds and other wildlife are a serious economic and public safety problem. While many species of wildlife can pose a threat to aircraft safety, they are not equally hazardous. Table 1 ranks the wildlife groups commonly involved in damaging strikes in the United States according to their relative hazard to aircraft. The ranking is based on the 47,212 records in the FAA National Wildlife Strike Database for the years 1990 through 2003. These hazard rankings, in conjunction with site-specific WHAs, will help airport operators determine the relative abundance and use patterns of wildlife species and help focus hazardous wildlife management efforts on those species most likely to cause problems at an airport.

Most public-use airports have large tracts of open, undeveloped land that provide added margins of safety and noise mitigation. These areas can also present potential hazards to aviation if they encourage wildlife to enter an airport's approach or departure airspace or air operations area (AOA). Constructed or natural areas—such as poorly drained locations, detention/retention ponds, roosting habitats on buildings, landscaping, odor-causing rotting organic matter (putrescible waste) disposal operations, wastewater treatment plants, agricultural or aquaculture activities, surface mining, or wetlands—can provide wildlife with ideal locations for feeding, loafing, reproduction, and escape. Even small facilities, such as fast food restaurants, taxicab staging areas, rental car facilities, aircraft viewing areas, and public parks, can produce substantial attractions for hazardous wildlife.

During the past century, wildlife-aircraft strikes have resulted in the loss of hundreds of lives worldwide, as well as billions of dollars in aircraft damage. Hazardous wildlife attractants on and near airports can jeopardize future airport expansion, making proper community land-use planning essential. This AC provides airport operators and those parties with whom they cooperate with the guidance they need to assess and address potentially hazardous wildlife attractants when locating new facilities and implementing certain land-use practices on or near public-use airports.

6. MEMORANDUM OF AGREEMENT BETWEEN FEDERAL RESOURCE AGENCIES. The FAA, the U.S. Air Force, the U.S. Army Corps of Engineers, the U.S. Environmental Protection Agency, the U.S. Fish and Wildlife Service, and the U.S. Department of Agriculture - Wildlife Services signed a Memorandum of Agreement (MOA) (final signature July 2003) to acknowledge their respective missions in protecting aviation from wildlife hazards. Through the MOA, the agencies established procedures necessary to coordinate their missions to address more effectively existing and future environmental conditions contributing to collisions between wildlife and aircraft (wildlife strikes) throughout the United States. These efforts are intended to minimize wildlife risks to aviation and human safety while protecting the Nation’s valuable environmental resources.

DAVID L. BENNETT

Director, Office of Airport Safety
and Standards

Table 1. Ranking of 25 species groups as to relative hazard to aircraft (1=most hazardous) based on three criteria (damage, major damage, and effect-on-flight), a composite ranking based on all three rankings, and a relative hazard score. Data were derived from the FAA National Wildlife Strike Database, January 1990–April 2003.[1]

Species group	Ranking by criteria			Composite ranking[2]	Relative hazard score[3]
	Damage[4]	Major damage[5]	Effect on flight[6]		
Deer	1	1	1	1	100
Vultures	2	2	2	2	64
Geese	3	3	6	3	55
Cormorants/pelicans	4	5	3	4	54
Cranes	7	6	4	5	47
Eagles	6	9	7	6	41
Ducks	5	8	10	7	39
Osprey	8	4	8	8	39
Turkey/pheasants	9	7	11	9	33
Herons	11	14	9	10	27
Hawks (buteos)	10	12	12	11	25
Gulls	12	11	13	12	24
Rock pigeon	13	10	14	13	23
Owls	14	13	20	14	23
H. lark/s. bunting	18	15	15	15	17
Crows/ravens	15	16	16	16	16
Coyote	16	19	5	17	14
Mourning dove	17	17	17	18	14
Shorebirds	19	21	18	19	10
Blackbirds/starling	20	22	19	20	10
American kestrel	21	18	21	21	9
Meadowlarks	22	20	22	22	7
Swallows	24	23	24	23	4
Sparrows	25	24	23	24	4
Nighthawks	23	25	25	25	1

[1] Excerpted from the *Special Report for the FAA, "Ranking the Hazard Level of Wildlife Species to Civil Aviation in the USA: Update #1, July 2, 2003".* Refer to this report for additional explanations of criteria and method of ranking.
[2] Relative rank of each species group was compared with every other group for the three variables, placing the species group with the greatest hazard rank for $\geq$ 2 of the 3 variables above the next highest ranked group, then proceeding down the list.
[3] Percentage values, from Tables 3 and 4 in Footnote 1 of the *Special Report*, for the three criteria were summed and scaled down from 100, with 100 as the score for the species group with the maximum summed values and the greatest potential hazard to aircraft.
[4] Aircraft incurred at least some damage (destroyed, substantial, minor, or unknown) from strike.
[5] Aircraft incurred damage or structural failure, which adversely affected the structure strength, performance, or flight characteristics, and which would normally require major repair or replacement of the affected component, or the damage sustained makes it inadvisable to restore aircraft to airworthy condition.
[6] Aborted takeoff, engine shutdown, precautionary landing, or other.

SECTION 1.

GENERAL SEPARATION CRITERIA FOR HAZARDOUS WILDLIFE ATTRACTANTS ON OR NEAR AIRPORTS.

1-1. INTRODUCTION. When considering proposed land uses, airport operators, local planners, and developers must take into account whether the proposed land uses, including new development projects, will increase wildlife hazards. Land-use practices that attract or sustain hazardous wildlife populations on or near airports can significantly increase the potential for wildlife strikes.

The FAA recommends the minimum separation criteria outlined below for land-use practices that attract hazardous wildlife to the vicinity of airports. Please note that FAA criteria include land uses that cause movement of hazardous wildlife onto, into, or across the airport's approach or departure airspace or air operations area (AOA). (See the discussion of the synergistic effects of surrounding land uses in Section 2-8 of this AC.)

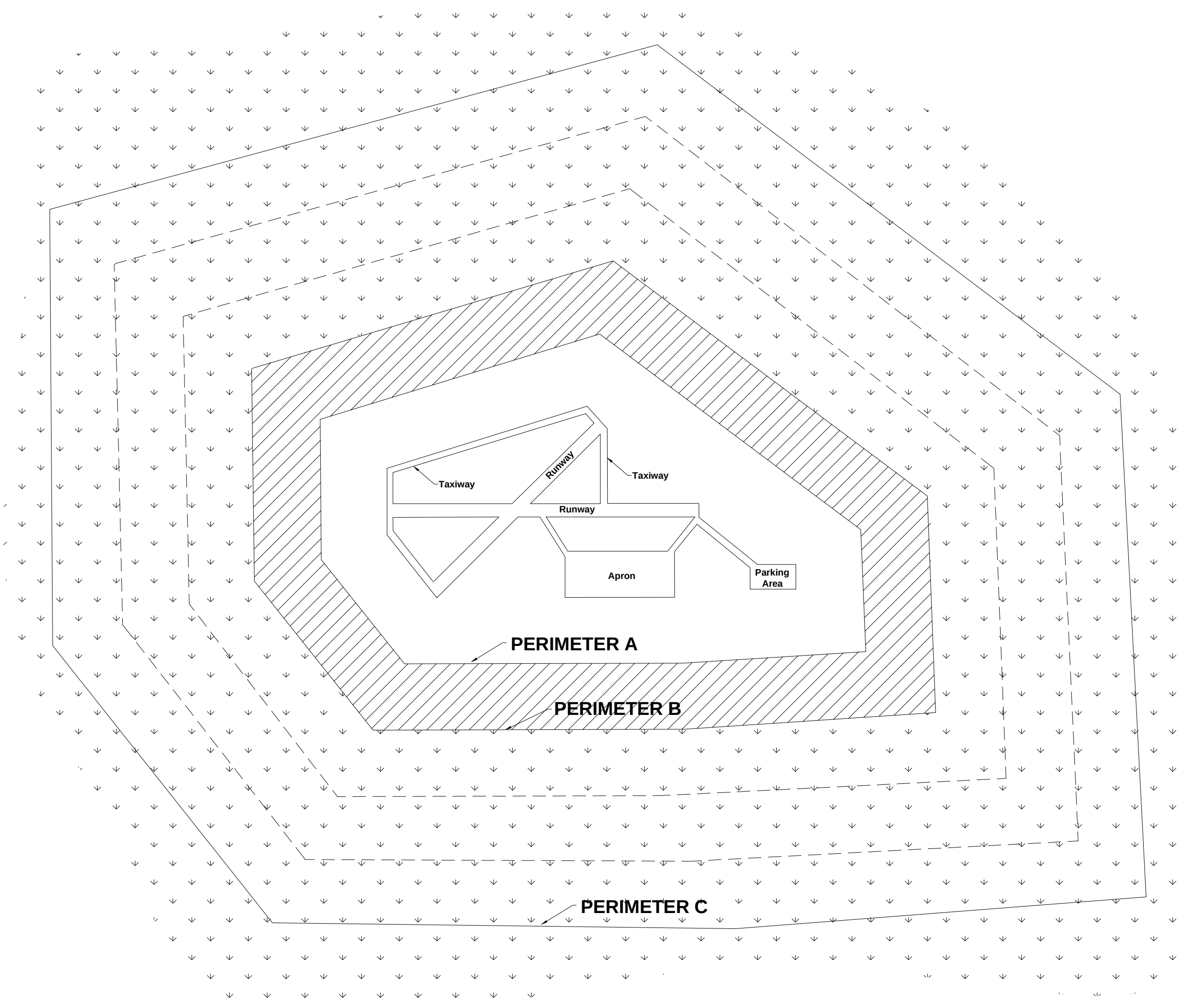
The basis for the separation criteria contained in this section can be found in existing FAA regulations. The separation distances are based on (1) flight patterns of piston-powered aircraft and turbine-powered aircraft, (2) the altitude at which most strikes happen (78 percent occur under 1,000 feet and 90 percent occur under 3,000 feet above ground level), and (3) National Transportation Safety Board (NTSB) recommendations.

1-2. AIRPORTS SERVING PISTON-POWERED AIRCRAFT. Airports that do not sell Jet-A fuel normally serve piston-powered aircraft. Notwithstanding more stringent requirements for specific land uses, the FAA recommends a separation distance of 5,000 feet at these airports for any of the hazardous wildlife attractants mentioned in Section 2 or for new airport development projects meant to accommodate aircraft movement. This distance is to be maintained between an airport's AOA and the hazardous wildlife attractant. Figure 1 depicts this separation distance measured from the nearest aircraft operations areas.

1-3. AIRPORTS SERVING TURBINE-POWERED AIRCRAFT. Airports selling Jet-A fuel normally serve turbine-powered aircraft. Notwithstanding more stringent requirements for specific land uses, the FAA recommends a separation distance of 10,000 feet at these airports for any of the hazardous wildlife attractants mentioned in Section 2 or for new airport development projects meant to accommodate aircraft movement. This distance is to be maintained between an airport's AOA and the hazardous wildlife attractant. Figure 1 depicts this separation distance from the nearest aircraft movement areas.

1-4. PROTECTION OF APPROACH, DEPARTURE, AND CIRCLING AIRSPACE. For all airports, the FAA recommends a distance of 5 statute miles between the farthest edge of the airport's AOA and the hazardous wildlife attractant if the attractant could cause hazardous wildlife movement into or across the approach or departure airspace.

Figure 1. Separation distances within which hazardous wildlife attractants should be avoided, eliminated, or mitigated.



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.

SECTION 2.

LAND-USE PRACTICES ON OR NEAR AIRPORTS THAT POTENTIALLY ATTRACT HAZARDOUS WILDLIFE.

2-1. GENERAL. The wildlife species and the size of the populations attracted to the airport environment vary considerably, depending on several factors, including land-use practices on or near the airport. This section discusses land-use practices having the potential to attract hazardous wildlife and threaten aviation safety. In addition to the specific considerations outlined below, airport operators should refer to *Wildlife Hazard Management at Airports,* prepared by FAA and U.S. Department of Agriculture (USDA) staff. (This manual is available in English, Spanish, and French. It can be viewed and downloaded free of charge from the FAA's wildlife hazard mitigation web site: http://wildlife-mitigation.tc.FAA.gov.). And, *Prevention and Control of Wildlife Damage,* compiled by the University of Nebraska Cooperative Extension Division. (This manual is available online in a periodically updated version at: ianrwww.unl.edu/wildlife/solutions/handbook/.)

2-2. WASTE DISPOSAL OPERATIONS. Municipal solid waste landfills (MSWLF) are known to attract large numbers of hazardous wildlife, particularly birds. Because of this, these operations, when located within the separations identified in the siting criteria in Sections 1-2 through 1-4, are considered incompatible with safe airport operations.

a. **Siting for new municipal solid waste landfills subject to AIR 21**. Section 503 of the Wendell H. Ford Aviation Investment and Reform Act for the 21st Century (Public Law 106-181) (AIR 21) prohibits the construction or establishment of a new MSWLF within 6 statute miles of certain public-use airports. Before these prohibitions apply, both the airport and the landfill must meet the very specific conditions described below. These restrictions do not apply to airports or landfills located within the state of Alaska.

The airport must (1) have received a Federal grant(s) under 49 U.S.C. § 47101, et. seq.; (2) be under control of a public agency; (3) serve some scheduled air carrier operations conducted in aircraft with less than 60 seats; and (4) have total annual enplanements consisting of at least 51 percent of scheduled air carrier enplanements conducted in aircraft with less than 60 passenger seats.

The proposed MSWLF must (1) be within 6 miles of the airport, as measured from airport property line to MSWLF property line, and (2) have started construction or establishment on or after April 5, 2001. Public Law 106-181 only limits the construction or establishment of some new MSWLF. It does not limit the expansion, either vertical or horizontal, of existing landfills.

NOTE: Consult the most recent version of AC 150/5200-34, *Construction or Establishment of Landfills Near Public Airports,* for a more detailed discussion of these restrictions.

b. **Siting for new MSWLF not subject to AIR 21**. If an airport and MSWLF do not meet the restrictions of Public Law 106-181, the FAA recommends against locating MSWLF within the separation distances identified in Sections 1-2 through 1-4. The separation distances should be measured from the closest point of the airport's AOA to the closest planned MSWLF cell.

c. **Considerations for existing waste disposal facilities within the limits of separation criteria.** The FAA recommends against airport development projects that would increase the number of aircraft operations or accommodate larger or faster aircraft near MSWLF operations located within the separations identified in Sections 1-2 through 1-4. In addition, in accordance with 40 CFR 258.10, owners or operators of existing MSWLF units that are located within the separations listed in Sections 1-2 through 1-4 must demonstrate that the unit is designed and operated so it does not pose a bird hazard to aircraft. (See Sections 4-3(b) and 4-3(c) of this AC for a discussion of this demonstration requirement.)

d. **Enclosed trash transfer stations.** Enclosed waste-handling facilities that receive garbage behind closed doors; process it via compaction, incineration, or similar manner; and remove all residue by enclosed vehicles generally are compatible with safe airport operations, provided they are not located on airport property or within the Runway Protection Zone (RPZ). These facilities should not handle or store putrescible waste outside or in a partially enclosed structure accessible to hazardous wildlife. Trash transfer facilities that are open on one or more sides; that store uncovered quantities of municipal solid waste outside, even if only for a short time; that use semi-trailers that leak or have trash clinging to the outside; or that do not control odors by ventilation and filtration systems (odor masking is not acceptable) do not meet the FAA's definition of fully enclosed trash transfer stations. The FAA considers these facilities incompatible with safe airport operations if they are located closer than the separation distances specified in Sections 1-2 through 1-4.

e. **Composting operations on or near airport property.** Composting operations that accept only yard waste (e.g., leaves, lawn clippings, or branches) generally do not attract hazardous wildlife. Sewage sludge, woodchips, and similar material are not municipal solid wastes and may be used as compost bulking agents. The compost, however, must never include food or other municipal solid waste. Composting operations should not be located on airport property. Off-airport property composting operations should be located no closer than the greater of the following distances: 1,200 feet from any AOA or the distance called for by airport design requirements (see AC 150/5300-13, *Airport Design*). This spacing should prevent material, personnel, or equipment from penetrating any Object Free Area (OFA), Obstacle Free Zone (OFZ), Threshold Siting Surface (TSS), or Clearway. Airport operators should monitor composting operations located in proximity to the airport to ensure that steam or thermal rise does not adversely affect air traffic. On-airport disposal of compost by-products should not be conducted for the reasons stated in 2-3f.

f. **Underwater waste discharges.** The FAA recommends against the underwater discharge of any food waste (e.g., fish processing offal) within the separations identified in Sections 1-2 through 1-4 because it could attract scavenging hazardous wildlife.

g. **Recycling centers.** Recycling centers that accept previously sorted non-food items, such as glass, newspaper, cardboard, or aluminum, are, in most cases, not attractive to hazardous wildlife and are acceptable.

h. **Construction and demolition (C&D) debris facilities.** C&D landfills do not generally attract hazardous wildlife and are acceptable if maintained in an orderly manner, admit no putrescible waste, and are not co-located with other waste disposal operations. However, C&D landfills have similar visual and operational characteristics to putrescible waste disposal sites. When co-located with putrescible waste disposal operations, C&D landfills are more likely to attract hazardous wildlife because of the similarities between these disposal facilities. Therefore, a C&D landfill co-located with another waste disposal operation should be located outside of the separations identified in Sections 1-2 through 1-4.

i. **Fly ash disposal.** The incinerated residue from resource recovery power/heat-generating facilities that are fired by municipal solid waste, coal, or wood is generally not a wildlife attractant because it no longer contains putrescible matter. Landfills accepting only fly ash are generally not considered to be wildlife attractants and are acceptable as long as they are maintained in an orderly manner, admit no putrescible waste of any kind, and are not co-located with other disposal operations that attract hazardous wildlife.

Since varying degrees of waste consumption are associated with general incineration (not resource recovery power/heat-generating facilities), the FAA considers the ash from general incinerators a regular waste disposal by-product and, therefore, a hazardous wildlife attractant if disposed of within the separation criteria outlined in Sections 1-2 through 1-4.

2-3. WATER MANAGEMENT FACILITIES. Drinking water intake and treatment facilities, storm water and wastewater treatment facilities, associated retention and settling ponds, ponds built for recreational use, and ponds that result from mining activities often attract large numbers of potentially hazardous wildlife. To prevent wildlife hazards, land-use developers and airport operators may need to develop management plans, in compliance with local and state regulations, to support the operation of storm water management facilities on or near all public-use airports to ensure a safe airport environment.

a. **Existing storm water management facilities.** On-airport storm water management facilities allow the quick removal of surface water, including discharges related to aircraft deicing, from impervious surfaces, such as pavement and terminal/hangar building roofs. Existing on-airport detention ponds collect storm water, protect water quality, and control runoff. Because they slowly release water after storms, they create standing bodies of water that can attract hazardous wildlife. Where the airport has developed a WHMP in accordance with Part 139, the FAA requires immediate correction of any wildlife hazards arising from existing storm water facilities located on or near airports, using appropriate wildlife hazard mitigation techniques. Airport operators should develop measures to minimize hazardous wildlife attraction in consultation with a wildlife damage management biologist.

Where possible, airport operators should modify storm water detention ponds to allow a maximum 48-hour detention period for the design storm. The FAA recommends that airport operators avoid or remove retention ponds and detention ponds featuring dead storage to eliminate standing water. Detention basins should remain totally dry between rainfalls. Where constant flow of water is anticipated through the basin, or where any portion of the basin bottom may remain wet, the detention facility should include a concrete or paved pad and/or ditch/swale in the bottom to prevent vegetation that may provide nesting habitat.

When it is not possible to drain a large detention pond completely, airport operators may use physical barriers, such as bird balls, wires grids, pillows, or netting, to deter birds and other hazardous wildlife. When physical barriers are used, airport operators must evaluate their use and ensure they will not adversely affect water rescue. Before installing any physical barriers over detention ponds on Part 139 airports, airport operators must get approval from the appropriate FAA Regional Airports Division Office.

The FAA recommends that airport operators encourage off-airport storm water treatment facility operators to incorporate appropriate wildlife hazard mitigation techniques into storm water treatment facility operating practices when their facility is located within the separation criteria specified in Sections 1-2 through 1-4.

b. **New storm water management facilities.** The FAA strongly recommends that off-airport storm water management systems located within the separations identified in Sections 1-2 through 1-4 be designed and operated so as not to create above-ground standing water. On-airport storm water detention ponds should be designed, engineered, constructed, and maintained for a maximum 48–hour detention period for the design storm and remain completely dry between storms. To facilitate the control of hazardous wildlife, the FAA recommends the use of steep-sided, narrow, linearly shaped water detention basins. When it is not possible to place these ponds away from an airport's AOA, airport operators should use physical barriers, such as bird balls, wires grids, pillows, or netting, to prevent access of hazardous wildlife to open water and minimize aircraft-wildlife interactions. When physical barriers are used, airport operators must evaluate their use and ensure they will not adversely affect water rescue. Before installing any physical barriers over detention ponds on Part 139 airports, airport operators must get approval from the appropriate FAA Regional Airports Division Office. All vegetation in or around detention basins that provide food or cover for hazardous wildlife should be eliminated. If soil conditions and other requirements allow, the FAA encourages the use of underground storm water infiltration systems, such as French drains or buried rock fields, because they are less attractive to wildlife.

c. **Existing wastewater treatment facilities.** The FAA strongly recommends that airport operators immediately correct any wildlife hazards arising from existing wastewater treatment facilities located on or near the airport. Where required, a WHMP developed in accordance with Part 139 will outline appropriate wildlife hazard mitigation techniques. Accordingly, airport operators should encourage wastewater treatment facility operators to incorporate measures, developed in consultation with a wildlife damage management biologist, to minimize hazardous wildlife attractants. Airport operators should also encourage those wastewater treatment facility operators to incorporate these mitigation techniques into their standard operating practices. In addition, airport operators should consider the existence of wastewater treatment facilities when evaluating proposed sites for new airport development projects and avoid such sites when practicable.

d. **New wastewater treatment facilities.** The FAA strongly recommends against the construction of new wastewater treatment facilities or associated settling ponds within the separations identified in Sections 1-2 through 1-4. Appendix 1 defines wastewater treatment facility as “any devices and/or systems used to store, treat, recycle, or reclaim municipal sewage or liquid industrial wastes.” The definition includes any pretreatment involving the reduction of the amount of pollutants or the elimination of pollutants prior to introducing such pollutants into a publicly owned treatment works (wastewater treatment facility). During the site-location analysis for wastewater treatment facilities, developers should consider the potential to attract hazardous wildlife if an airport is in the vicinity of the proposed site, and airport operators should voice their opposition to such facilities if they are in proximity to the airport.

e. **Artificial marshes.** In warmer climates, wastewater treatment facilities sometimes employ artificial marshes and use submergent and emergent aquatic vegetation as natural filters. These artificial marshes may be used by some species of flocking birds, such as blackbirds and waterfowl, for breeding or roosting activities. The FAA strongly recommends against establishing artificial marshes within the separations identified in Sections 1-2 through 1-4.

f. **Wastewater discharge and sludge disposal.** The FAA recommends against the discharge of wastewater or sludge on airport property because it may improve soil moisture and quality on unpaved areas and lead to improved turf growth that can be an attractive food source for many species of animals. Also, the turf requires more frequent mowing, which in turn may mutilate or flush insects or small animals and produce straw, both of which can attract hazardous wildlife. In addition, the improved turf may attract grazing wildlife, such as deer and geese. Problems may also occur when discharges saturate unpaved airport areas. The resultant soft, muddy conditions can severely restrict or prevent emergency vehicles from reaching accident sites in a timely manner.

2-4. WETLANDS. Wetlands provide a variety of functions and can be regulated by local, state, and Federal laws. Normally, wetlands are attractive to many types of wildlife, including many which rank high on the list of hazardous wildlife species (Table 1).

NOTE: If questions exist as to whether an area qualifies as a wetland, contact the local division of the U.S. Army Corps of Engineers, the Natural Resources Conservation Service, or a wetland consultant qualified to delineate wetlands.

a. **Existing wetlands on or near airport property.** If wetlands are located on or near airport property, airport operators should be alert to any wildlife use or habitat changes in these areas that could affect safe aircraft operations. At public-use airports, the FAA recommends immediately correcting, in cooperation with local, state, and Federal regulatory agencies, any wildlife hazards arising from existing wetlands located on or near airports. Where required, a WHMP will outline appropriate wildlife hazard mitigation techniques. Accordingly, airport operators should develop measures to minimize hazardous wildlife attraction in consultation with a wildlife damage management biologist.

b. **New airport development.** Whenever possible, the FAA recommends locating new airports using the separations from wetlands identified in Sections 1-2 through 1-4. Where alternative sites are not practicable, or when airport operators are expanding an existing airport into or near wetlands, a wildlife damage management biologist, in consultation with the U.S. Fish and Wildlife Service, the U.S. Army Corps of Engineers, and the state wildlife management agency should evaluate the wildlife hazards and prepare a WHMP that indicates methods of minimizing the hazards.

c. **Mitigation for wetland impacts from airport projects.** Wetland mitigation may be necessary when unavoidable wetland disturbances result from new airport development projects or projects required to correct wildlife hazards from wetlands. Wetland mitigation must be designed so it does not create a wildlife hazard. The FAA recommends that wetland mitigation projects that may attract hazardous wildlife be sited outside of the separations identified in Sections 1-2 through 1-4.

(1) Onsite mitigation of wetland functions. The FAA may consider exceptions to locating mitigation activities outside the separations identified in Sections 1-2 through 1-4 if the affected wetlands provide unique ecological functions, such as critical habitat for threatened or endangered species or ground water recharge, which cannot be replicated when moved to a different location. Using existing airport property is sometimes the only feasible way to achieve the mitigation ratios mandated in regulatory orders and/or settlement agreements with the resource agencies. Conservation easements are an additional means of providing mitigation for project impacts. Typically the airport operator continues to own the property, and an easement is created stipulating that the property will be maintained as habitat for state or Federally listed species.

Mitigation must not inhibit the airport operator's ability to effectively control hazardous wildlife on or near the mitigation site or effectively maintain other aspects of safe airport operations. Enhancing such mitigation areas to attract hazardous wildlife must be avoided. The FAA will review any onsite mitigation proposals to determine compatibility with safe airport operations. A wildlife damage management biologist should evaluate any wetland mitigation projects that are needed to protect unique wetland functions and that must be located in the separation criteria in Sections 1-2 through 1-4 before the mitigation is implemented. A WHMP should be developed to reduce the wildlife hazards.

(2) Offsite mitigation of wetland functions. The FAA recommends that wetland mitigation projects that may attract hazardous wildlife be sited outside of the separations identified in Sections 1-2 through 1-4 unless they provide unique functions that must remain onsite (see 2-4c(1)). Agencies that regulate impacts to or

around wetlands recognize that it may be necessary to split wetland functions in mitigation schemes. Therefore, regulatory agencies may, under certain circumstances, allow portions of mitigation to take place in different locations.

(3) Mitigation banking. Wetland mitigation banking is the creation or restoration of wetlands in order to provide mitigation credits that can be used to offset permitted wetland losses. Mitigation banking benefits wetland resources by providing advance replacement for permitted wetland losses; consolidating small projects into larger, better-designed and managed units; and encouraging integration of wetland mitigation projects with watershed planning. This last benefit is most helpful for airport projects, as wetland impacts mitigated outside of the separations identified in Sections 1-2 through 1-4 can still be located within the same watershed. Wetland mitigation banks meeting the separation criteria offer an ecologically sound approach to mitigation in these situations. Airport operators should work with local watershed management agencies or organizations to develop mitigation banking for wetland impacts on airport property.

2-5. DREDGE SPOIL CONTAINMENT AREAS. The FAA recommends against locating dredge spoil containment areas (also known as Confined Disposal Facilities) within the separations identified in Sections 1-2 through 1-4 if the containment area or the spoils contain material that would attract hazardous wildlife.

2-6. AGRICULTURAL ACTIVITIES. Because most, if not all, agricultural crops can attract hazardous wildlife during some phase of production, the FAA recommends against the used of airport property for agricultural production, including hay crops, within the separations identified in Sections 1-2 through 1-4. . If the airport has no financial alternative to agricultural crops to produce income necessary to maintain the viability of the airport, then the airport shall follow the crop distance guidelines listed in the table titled "Minimum Distances between Certain Airport Features and Any On-Airport Agricultural Crops" found in AC 150/5300-13, *Airport Design*, Appendix 19. The cost of wildlife control and potential accidents should be weighed against the income produced by the on-airport crops when deciding whether to allow crops on the airport.

a. **Livestock production.** Confined livestock operations (i.e., feedlots, dairy operations, hog or chicken production facilities, or egg laying operations) often attract flocking birds, such as starlings, that pose a hazard to aviation. Therefore, The FAA recommends against such facilities within the separations identified in Sections 1-2 through 1-4. Any livestock operation within these separations should have a program developed to reduce the attractiveness of the site to species that are hazardous to aviation safety. Free-ranging livestock must not be grazed on airport property because the animals may wander onto the AOA. Furthermore, livestock feed, water, and manure may attract birds.

b. **Aquaculture.** Aquaculture activities (i.e. catfish or trout production) conducted outside of fully enclosed buildings are inherently attractive to a wide variety of birds. Existing aquaculture facilities/activities within the separations listed in Sections 1-2 through 1-4 must have a program developed to reduce the attractiveness of the sites to species that are hazardous to aviation safety. Airport operators should also oppose the establishment of new aquaculture facilities/activities within the separations listed in Sections 1-2 through 1-4.

c. **Alternative uses of agricultural land.** Some airports are surrounded by vast areas of farmed land within the distances specified in Sections 1-2 through 1-4. Seasonal uses of agricultural land for activities such as hunting can create a hazardous wildlife situation. In some areas, farmers will rent their land for hunting purposes. Rice farmers, for example, flood their land during waterfowl hunting season and obtain additional revenue by renting out duck blinds. The duck hunters then use decoys and call in hundreds, if not thousands, of birds, creating a tremendous threat to aircraft safety. A wildlife damage management biologist should review, in coordination with local farmers and producers, these types of seasonal land uses and incorporate them into the WHMP.

2-7. GOLF COURSES, LANDSCAPING AND OTHER LAND-USE CONSIDERATIONS.

a. **Golf courses.** The large grassy areas and open water found on most golf courses are attractive to hazardous wildlife, particularly Canada geese and some species of gulls. These species can pose a threat to aviation safety. The FAA recommends against construction of new golf courses within the separations identified in Sections 1-2 through 1-4. Existing golf courses located within these separations must develop a program to reduce the attractiveness of the sites to species that are hazardous to aviation safety. Airport operators should ensure these golf courses are monitored on a continuing basis for the presence of hazardous wildlife. If hazardous wildlife is detected, corrective actions should be immediately implemented.

b. **Landscaping and landscape maintenance.** Depending on its geographic location, landscaping can attract hazardous wildlife. The FAA recommends that airport operators approach landscaping with caution and confine it to airport areas not associated with aircraft movements. A wildlife damage management biologist should review all landscaping plans. Airport operators should also monitor all landscaped areas on a continuing basis for the presence of hazardous wildlife. If hazardous wildlife is detected, corrective actions should be immediately implemented.

Turf grass areas can be highly attractive to a variety of hazardous wildlife species. Research conducted by the USDA Wildlife Services' National Wildlife Research Center has shown that no one grass management regime will deter all species of hazardous wildlife in all situations. In cooperation with wildlife damage management biologist, airport operators should develop airport turf grass management plans on a prescription basis, depending on the airport's geographic locations and the type of hazardous wildlife likely to frequent the airport

Airport operators should ensure that plant varieties attractive to hazardous wildlife are not used on the airport. Disturbed areas or areas in need of re-vegetating should not be planted with seed mixtures containing millet or any other large-seed producing grass. For airport property already planted with seed mixtures containing millet, rye grass, or other large-seed producing grasses, the FAA recommends disking, plowing, or another suitable agricultural practice to prevent plant maturation and seed head production. Plantings should follow the specific recommendations for grass management and seed and plant selection made by the State University Cooperative Extension Service, the local office of Wildlife Services, or a qualified wildlife damage management biologist. Airport operators should also consider developing and implementing a preferred/prohibited plant species list, reviewed by a wildlife damage management biologist, which has been designed for the geographic location to reduce the attractiveness to hazardous wildlife for landscaping airport property.

c. **Airports surrounded by wildlife habitat.** The FAA recommends that operators of airports surrounded by woodlands, water, or wetlands refer to Section 2.4 of this AC. Operators of such airports should provide for a WHA conducted by a wildlife damage management biologist. This WHA is the first step in preparing a WHMP, where required.

d. **Other hazardous wildlife attractants.** Other specific land uses or activities (e.g., sport or commercial fishing, shellfish harvesting, etc.), perhaps unique to certain regions of the country, have the potential to attract hazardous wildlife. Regardless of the source of the attraction, when hazardous wildlife is noted on a public-use airport, airport operators must take prompt remedial action(s) to protect aviation safety.

2-8. SYNERGISTIC EFFECTS OF SURROUNDING LAND USES. There may be circumstances where two (or more) different land uses that would not, by themselves, be considered hazardous wildlife attractants or that are located outside of the separations identified in Sections 1-2 through 1-4 that are in such an alignment with the airport as to create a wildlife corridor directly through the airport and/or surrounding airspace. An example of this situation may involve a lake located outside of the separation criteria on the east side of an airport and a large hayfield on the west side of an airport, land uses that together could create a flyway for Canada geese directly across the airspace of the airport. There are numerous examples of such situations; therefore, airport operators and the wildlife damage management biologist must consider the entire surrounding landscape and community when developing the WHMP.

SECTION 3.

PROCEDURES FOR WILDLIFE HAZARD MANAGEMENT BY OPERATORS OF PUBLIC-USE AIRPORTS.

3.1. INTRODUCTION. In recognition of the increased risk of serious aircraft damage or the loss of human life that can result from a wildlife strike, the FAA may require the development of a Wildlife Hazard Management Plan (WHMP) when specific triggering events occur on or near the airport. Part 139.337 discusses the specific events that trigger a Wildlife Hazard Assessment (WHA) and the specific issues that a WHMP must address for FAA approval and inclusion in an Airport Certification Manual.

3.2. COORDINATION WITH USDA WILDLIFE SERVICES OR OTHER QUALIFIED WILDLIFE DAMAGE MANAGEMENT BIOLOGISTS. The FAA will use the WHA conducted in accordance with Part 139 to determine if the airport needs a WHMP. Therefore, persons having the education, training, and expertise necessary to assess wildlife hazards must conduct the WHA. The airport operator may look to Wildlife Services or to qualified private consultants to conduct the WHA. When the services of a wildlife damage management biologist are required, the FAA recommends that land-use developers or airport operators contact a consultant specializing in wildlife damage management or the appropriate state director of Wildlife Services.

NOTE: Telephone numbers for the respective USDA Wildlife Services state offices can be obtained by contacting USDA Wildlife Services Operational Support Staff, 4700 River Road, Unit 87, Riverdale, MD, 20737-1234, Telephone (301) 734-7921, Fax (301) 734-5157 *(http://www.aphis.usda.gov/ws/)*.

3-3. WILDLIFE HAZARD MANAGEMENT AT AIRPORTS: A MANUAL FOR AIRPORT PERSONNEL. This manual, prepared by FAA and USDA Wildlife Services staff, contains a compilation of information to assist airport personnel in the development, implementation, and evaluation of WHMPs at airports. The manual includes specific information on the nature of wildlife strikes, legal authority, regulations, wildlife management techniques, WHAs, WHMPs, and sources of help and information. The manual is available in three languages: English, Spanish, and French. It can be viewed and downloaded free of charge from the FAA's wildlife hazard mitigation web site: http://wildlife-mitigation.tc.FAA.gov/. This manual only provides a starting point for addressing wildlife hazard issues at airports. Hazardous wildlife management is a complex discipline and conditions vary widely across the United States. Therefore, qualified wildlife damage management biologists must direct the development of a WHMP and the implementation of management actions by airport personnel.

There are many other resources complementary to this manual for use in developing and implementing WHMPs. Several are listed in the manual's bibliography.

3-4. WILDLIFE HAZARD ASSESSMENTS, TITLE 14, CODE OF FEDERAL REGULATIONS, PART 139. Part 139.337(b) requires airport operators to conduct a Wildlife Hazard Assessment (WHA) when certain events occur on or near the airport. Part 139.337 (c) provides specific guidance as to what facts must be addressed in a WHA.

3-5. WILDLIFE HAZARD MANAGEMENT PLAN (WHMP). The FAA will consider the results of the WHA, along with the aeronautical activity at the airport and the views of the airport operator and airport users, in determining whether a formal WHMP is needed, in accordance with Part 139.337. If the FAA determines that a WHMP is needed, the airport operator must formulate and implement a WHMP, using the WHA as the basis for the plan.

The goal of an airport's Wildlife Hazard Management Plan is to minimize the risk to aviation safety, airport structures or equipment, or human health posed by populations of hazardous wildlife on and around the airport.

The WHMP must identify hazardous wildlife attractants on or near the airport and the appropriate wildlife damage management techniques to minimize the wildlife hazard. It must also prioritize the management measures.

3-6. LOCAL COORDINATION. The establishment of a Wildlife Hazards Working Group (WHWG) will facilitate the communication, cooperation, and coordination of the airport and its surrounding community necessary to ensure the effectiveness of the WHMP. The cooperation of the airport community is also necessary when new projects are considered. Whether on or off the airport, the input from all involved parties must be considered when a potentially hazardous wildlife attractant is being proposed. Airport operators should also incorporate public education activities with the local coordination efforts because some activities in the vicinity of your airport, while harmless under normal leisure conditions, can attract wildlife and present a danger to aircraft. For example, if public trails are planned near wetlands or in parks adjoining airport property, the public should know that feeding birds and other wildlife in the area may pose a risk to aircraft.

Airport operators should work with local and regional planning and zoning boards so as to be aware of proposed land-use changes, or modification of existing land uses, that could create hazardous wildlife attractants within the separations identified in Sections 1-2 through 1-4. Pay particular attention to proposed land uses involving creation or expansion of waste water treatment facilities, development of wetland mitigation sites, or development or expansion of dredge spoil containment areas. At the very least, airport operators must ensure they are on the notification list of the local planning board or equivalent review entity for all communities located within 5 miles of the airport, so they will receive notification of any proposed project and have the opportunity to review it for attractiveness to hazardous wildlife.

3-7 COORDINATION/NOTIFICATION OF AIRMEN OF WILDLIFE HAZARDS. If an existing land-use practice creates a wildlife hazard and the land-use practice or wildlife hazard cannot be immediately eliminated, airport operators must issue a Notice to Airmen (NOTAM) and encourage the land–owner or manager to take steps to control the wildlife hazard and minimize further attraction.

SECTION 4.

FAA NOTIFICATION AND REVIEW OF PROPOSED LAND-USE PRACTICE CHANGES IN THE VICINITY OF PUBLIC USE AIRPORTS

4-1. FAA REVIEW OF PROPOSED LAND-USE PRACTICE CHANGES IN THE VICINITY OF PUBLIC USE AIRPORTS.

a. The FAA discourages the development of waste disposal and other facilities, discussed in Section 2, located within the 5,000/10,000-foot criteria specified in Sections 1-2 through 1-4.

b. For projects that are located outside the 5,000/10,000-foot criteria but within 5 statute miles of the airport's AOA, the FAA may review development plans, proposed land-use changes, operational changes, or wetland mitigation plans to determine if such changes present potential wildlife hazards to aircraft operations. The FAA considers sensitive airport areas as those that lie under or next to approach or departure airspace. This brief examination should indicate if further investigation is warranted.

c. Where a wildlife damage management biologist has conducted a further study to evaluate a site's compatibility with airport operations, the FAA may use the study results to make a determination.

4-2. WASTE MANAGEMENT FACILITIES.

a. **Notification of new/expanded project proposal.** Section 503 of the Wendell H. Ford Aviation Investment and Reform Act for the 21st Century (Public Law 106-181) limits the construction or establishment of new MSWLF within 6 statute miles of certain public use airports, when both the airport and the landfill meet very specific conditions. See Section 2-2 of this AC and AC 150/5200-34 for a more detailed discussion of these restrictions.

   The Environmental Protection Agency (EPA) requires any MSWLF operator proposing a new or expanded waste disposal operation within 5 statute miles of a runway end to notify the appropriate FAA Regional Airports Division Office and the airport operator of the proposal (40 CFR 258, *Criteria for Municipal Solid Waste Landfills*, Section 258.10, *Airport Safety*). The EPA also requires owners or operators of new MSWLF units, or lateral expansions of existing MSWLF units, that are located within 10,000 feet of any airport runway end used by turbojet aircraft, or within 5,000 feet of any airport runway end used only by piston-type aircraft, to demonstrate successfully that such units are not hazards to aircraft. (See 4-2.b below.)

   When new or expanded MSWLF are being proposed near airports, MSWLF operators must notify the airport operator and the FAA of the proposal as early as possible pursuant to 40 CFR 258.

Waste handling facilities within separations identified in Sections 1-2 through 1-4. To claim successfully that a waste-handling facility sited within the separations identified in Sections 1-2 through 1-4 does not attract hazardous wildlife and does not threaten aviation, the developer must establish convincingly that the facility will not handle putrescible material other than that as outlined in 2-2b. The FAA strongly recommends against any facility other than that as outlined in 2-2b (enclosed transfer stations). The FAA will use this information to determine if the facility will be a hazard to aviation.

b. **Putrescible-Waste Facilities.** In their effort to satisfy the EPA requirement, some putrescible-waste facility proponents may offer to undertake experimental measures to demonstrate that their proposed facility will not be a hazard to aircraft. To date, no such facility has been able to demonstrate an ability to reduce and sustain hazardous wildlife to levels that existed before the putrescible-waste landfill began operating. For this reason, demonstrations of experimental wildlife control measures may not be conducted in an airport's AOA.

4-3. OTHER LAND-USE PRACTICE CHANGES. As a matter of policy, the FAA encourages operators of public use airports who become aware of proposed land use practice changes that may attract hazardous wildlife within 5 statute miles of their airports to promptly notify the FAA. The FAA also encourages proponents of such land use changes to notify the FAA as early in the planning process as possible. Advanced notice affords the FAA an opportunity (1) to evaluate the effect of a particular land-use change on aviation safety and (2) to support efforts by the airport sponsor to restrict the use of land next to or near the airport to uses that are compatible with the airport.

The airport operator, project proponent, or land-use operator may use FAA Form 7460-1, *Notice of Proposed Construction or Alteration*, or other suitable documents similar to FAA Form 7460-1 to notify the appropriate FAA Regional Airports Division Office. Project proponents can contact the appropriate FAA Regional Airports Division Office for assistance with the notification process.

It is helpful if the notification includes a 15-minute quadrangle map of the area identifying the location of the proposed activity. The land-use operator or project proponent should also forward specific details of the proposed land-use change or operational change or expansion. In the case of solid waste landfills, the information should include the type of waste to be handled, how the waste will be processed, and final disposal methods.

a. **Airports that have received Federal grant-in-aid assistance.** Airports that have received Federal grant-in-aid assistance are required by their grant assurances to take appropriate actions to restrict the use of land next to or near the airport to uses that are compatible with normal airport operations. The FAA recommends that airport operators to the extent practicable oppose off-airport land-use changes or practices within the separations identified in Sections 1-2 through 1-4 that may attract hazardous wildlife. Failure to do so may lead to noncompliance with applicable grant assurances. The FAA will not approve the placement of airport development projects pertaining to aircraft movement in the vicinity of hazardous wildlife attractants without appropriate mitigating measures. Increasing the intensity of wildlife control efforts is not a substitute for eliminating or reducing a proposed wildlife hazard. Airport operators should identify hazardous wildlife attractants and any associated wildlife hazards during any planning process for new airport development projects.

b. **Additional coordination.** If, after initial review by the FAA, questions remain about the existence of a wildlife hazard near an airport, airport operators should consult a wildlife damage management biologist. Such questions may be triggered by a history of wildlife strikes at the airport or the proximity of the airport to a wildlife refuge, body of water, or similar feature known to attract wildlife. Once identified, such questions require resolution prior to the project's implementation.

APPENDIX 1. DEFINITIONS OF TERMS USED IN THIS ADVISORY CIRCULAR.

1. GENERAL. This appendix provides definitions of terms used throughout this AC.

1. **Air operations area.** Any area of an airport used or intended to be used for landing, takeoff, or surface maneuvering of aircraft. An air operations area includes such paved areas or unpaved areas that are used or intended to be used for the unobstructed movement of aircraft in addition to its associated runway, taxiways, or apron.
2. **Airport operator.** The operator (private or public) or sponsor of a public-use airport.
3. **Approach or departure airspace.** The airspace, within 5 statute miles of an airport, through which aircraft move during landing or takeoff.
4. **Bird balls.** High-density plastic floating balls that can be used to cover ponds and prevent birds from using the sites.
5. **Certificate holder.** The holder of an Airport Operating Certificate issued under Title 14, Code of Federal Regulations, Part 139.
6. **Construct a new MSWLF.** To begin to excavate, grade land, or raise structures to prepare a municipal solid waste landfill as permitted by the appropriate regulatory or permitting agency.
7. **Detention ponds.** Storm water management ponds that hold storm water for short periods of time, a few hours to a few days.
8. **Establish a new MSWLF.** When the first load of putrescible waste is received on-site for placement in a prepared municipal solid waste landfill.
9. **Fly ash.** The fine, sand-like residue resulting from the complete incineration of an organic fuel source. Fly ash typically results from the combustion of coal or waste used to operate a power generating plant.
10. **General aviation aircraft.** Any civil aviation aircraft not operating under 14 CFR Part 119, Certification: Air Carriers and Commercial Operators.
11. **Hazardous wildlife.** Species of wildlife (birds, mammals, reptiles), including feral animals and domesticated animals not under control, that are associated with aircraft strike problems, are capable of causing structural damage to airport facilities, or act as attractants to other wildlife that pose a strike hazard
12. **Municipal Solid Waste Landfill (MSWLF).** A publicly or privately owned discrete area of land or an excavation that receives household waste and that is not a land application unit, surface impoundment, injection well, or waste pile, as those terms are defined under 40 CFR § 257.2. An MSWLF may receive other types wastes, such as commercial solid waste, non-hazardous sludge, small-quantity generator waste, and industrial solid waste, as defined under 40 CFR § 258.2. An MSWLF can consist of either a stand alone unit or several cells that receive household waste.
13. **New MSWLF**. A municipal solid waste landfill that was established or constructed after April 5, 2001.

14. **Piston-powered aircraft.** Fixed-wing aircraft powered by piston engines.

15. **Piston-use airport.** Any airport that does not sell Jet-A fuel for fixed-wing turbine-powered aircraft, and primarily serves fixed-wing, piston-powered aircraft. Incidental use of the airport by turbine-powered, fixed-wing aircraft would not affect this designation. However, such aircraft should not be based at the airport.

16. **Public agency**. A State or political subdivision of a State, a tax-supported organization, or an Indian tribe or pueblo (49 U.S.C. § 47102(15)).

17. **Public airport.** An airport used or intended to be used for public purposes that is under the control of a public agency; and of which the area used or intended to be used for landing, taking off, or surface maneuvering of aircraft is publicly owned (49 U.S.C. § 47102(16)).

18. **Putrescible waste.** Solid waste that contains organic matter capable of being decomposed by micro-organisms and of such a character and proportion as to be capable of attracting or providing food for birds (40 CFR §257.3-8).

19. **Putrescible-waste disposal operation.** Landfills, garbage dumps, underwater waste discharges, or similar facilities where activities include processing, burying, storing, or otherwise disposing of putrescible material, trash, and refuse.

20. **Retention ponds.** Storm water management ponds that hold water for several months.

21. **Runway protection zone (RPZ).** An area off the runway end to enhance the protection of people and property on the ground (see AC 150/5300-13). The dimensions of this zone vary with the airport design, aircraft, type of operation, and visibility minimum.

22. **Scheduled air carrier operation.** Any common carriage passenger-carrying operation for compensation or hire conducted by an air carrier or commercial operator for which the air carrier, commercial operator, or their representative offers in advance the departure location, departure time, and arrival location. It does not include any operation that is conducted as a supplemental operation under 14 CFR Part 119 or as a public charter operation under 14 CFR Part 380 (14 CFR § 119.3).

23. **Sewage sludge.** Any solid, semi-solid, or liquid residue generated during the treatment of domestic sewage in a treatment works. Sewage sludge includes, but is not limited to, domestic septage; scum or solids removed in primary, secondary, or advanced wastewater treatment process; and a material derived from sewage sludge. Sewage does not include ash generated during the firing of sewage sludge in a sewage sludge incinerator or grit and screenings generated during preliminary treatment of domestic sewage in a treatment works. (40 CFR 257.2)

24. **Sludge.** Any solid, semi-solid, or liquid waste generated form a municipal, commercial or industrial wastewater treatment plant, water supply treatment plant, or air pollution control facility or any other such waste having similar characteristics and effect. (40 CFR 257.2)

25. **Solid waste**. Any garbage, refuse, sludge, from a waste treatment plant, water

supply treatment plant or air pollution control facility and other discarded material, including, solid liquid, semisolid, or contained gaseous material resulting from industrial, commercial, mining, and agricultural operations, and from community activities, but does not include solid or dissolved materials in domestic sewage, or solid or dissolved material in irrigation return flows or industrial discharges which are point sources subject to permits under section 402 of the Federal Water Pollution Control Act, as amended (86 Stat. 880), or source, special nuclear, or by product material as defined by the Atomic Energy Act of 1954, as amended, (68 Stat. 923). (40 CFR 257.2)

26. **Turbine-powered aircraft.** Aircraft powered by turbine engines including turbojets and turboprops but excluding turbo-shaft rotary-wing aircraft.

27. **Turbine-use airport.** Any airport that sells Jet-A fuel for fixed-wing turbine-powered aircraft.

28. **Wastewater treatment facility.** Any devices and/or systems used to store, treat, recycle, or reclaim municipal sewage or liquid industrial wastes, including Publicly Owned Treatment Works (POTW), as defined by Section 212 of the Federal Water Pollution Control Act (P.L. 92-500) as amended by the Clean Water Act of 1977 (P.L. 95-576) and the Water Quality Act of 1987 (P.L. 100-4). This definition includes any pretreatment involving the reduction of the amount of pollutants, the elimination of pollutants, or the alteration of the nature of pollutant properties in wastewater prior to or in lieu of discharging or otherwise introducing such pollutants into a POTW. (See 40 CFR Section 403.3 (o), (p), & (q)).

29. **Wildlife.** Any wild animal, including without limitation any wild mammal, bird, reptile, fish, amphibian, mollusk, crustacean, arthropod, coelenterate, or other invertebrate, including any part, product, egg, or offspring thereof (50 CFR 10.12, *Taking, Possession, Transportation, Sale, Purchase, Barter, Exportation, and Importation of Wildlife and Plants*). As used in this AC, wildlife includes feral animals and domestic animals out of the control of their owners (14 CFR Part 139, Certification of Airports).

30. **Wildlife attractants.** Any human-made structure, land-use practice, or human-made or natural geographic feature that can attract or sustain hazardous wildlife within the landing or departure airspace or the airport's AOA. These attractants can include architectural features, landscaping, waste disposal sites, wastewater treatment facilities, agricultural or aquaculture activities, surface mining, or wetlands.

31. **Wildlife hazard.** A potential for a damaging aircraft collision with wildlife on or near an airport.

32. **Wildlife strike**. A wildlife strike is deemed to have occurred when:

    a. A pilot reports striking 1 or more birds or other wildlife;

    b. Aircraft maintenance personnel identify aircraft damage as having been caused by a wildlife strike;

    c. Personnel on the ground report seeing an aircraft strike 1 or more birds or other wildlife;

d. Bird or other wildlife remains, whether in whole or in part, are found within 200 feet of a runway centerline, unless another reason for the animal's death is identified;

e. The animal's presence on the airport had a significant negative effect on a flight (i.e., aborted takeoff, aborted landing, high-speed emergency stop, aircraft left pavement area to avoid collision with animal) (Transport Canada, Airports Group, *Wildlife Control Procedures Manual*, Technical Publication 11500E, 1994).

2. RESERVED

AC 150/5200-34
Construction or Establishment of Landfills Near Public Airports

U.S. Department of Transportation **Federal Aviation Administration**	**Advisory Circular**	
SUBJECT: CONSTRUCTION OR ESTABLISHMENT OF LANDFILLS NEAR PUBLIC AIRPORTS	**Date:** 8/26/2000 **Initiated by**: AAS-300	**AC No**: 150/5200-34 **Change:**

1. Purpose. This advisory circular (AC) contains guidance on complying with new Federal statutory requirements regarding the construction or establishment of landfills near public airports.

2. Application. The guidance contained in the AC is provided by the Federal Aviation Administration (FAA) for use by persons considering the construction or establishment of a municipal solid waste landfill (MSWLF) near a public airport. Guidance contained herein should be used to comply with recently enacted MSWLF site limitations contained in 49 U.S.C. § 44718(d), as amended by section 503 of the Wendell H. Ford Aviation Investment and Reform Act for the 21st Century, Pub. L. No. 106-181 (April 5, 2000), "Structures interfering with air commerce." In accordance with § 44718(d), as amended, these site limitations are not applicable in the State of Alaska.

In addition, this AC provides guidance for a state aviation agency desiring to petition the FAA for an exemption from the requirements of § 44718(d), as amended.

3. Related Reading Materials.

a. AC - 150/5200-33, Hazardous Wildlife Attractions On or Near Airports, May 1, 1997.

b. Wildlife Strikes to Civil Aircraft in the United States 1990-1998, FAA Wildlife Aircraft Strike Database Serial Report Number 5, November 1998.

c. Report to Congress: Potential Hazards to Aircraft by Locating Waste Disposal Sites in the Vicinity of Airports, April 1996, DOT/FAA/AS/96-1.

d. Title 14, Code of Federal Regulation, Part 139, Certification and Operations: Land Airports Serving Certain Air Carriers.

e. Title 40, Code of Federal Regulation, Part 258, Municipal Solid Waste Landfill Criteria.

Some of these documents and additional information on wildlife management, including guidance on landfills, are available on the FAA's Airports web site at www.faa.gov/arp/arphome.htm.

4. Definitions. Definitions for the specific purpose of this AC are found in Appendix 1.

5. Background. The FAA has the broad authority to regulate and develop civil aviation under the Federal Aviation Act of 1958, 49 U.S.C. § 40101, et. seq., and other Federal law. In section 1220 of the Federal Aviation Reauthorization Act of 1996, Pub. L. No. 104-264 (October 9, 1996), the Congress added a new provision, section (d), to 49 U.S.C. § 44718 to be enforced by the FAA and placing limitations on the construction or establishment of landfills near public airports for the purposes of enhancing aviation safety. Section 503 of the Wendell H. Ford Aviation Investment and Reform Act for the 21st Century (AIR-21), Pub. L. No. 106-181 (April 5, 2000) has replaced section 1220 of the 1996 Reauthorization Act, 49 U.S.C. § 44718 (d), with new language. Specifically, the new provision, § 44718(d), as amended, was enacted to further limit the construction or establishment of a MSWLF near certain smaller public airports.

In enacting this legislation, Congress expressed concern that a MSWLF sited near an airport poses a potential hazard to aircraft operations because such a waste facility attracts birds. Statistics support the fact that bird strikes pose a real danger to aircraft. An estimated 87 percent of the collisions between wildlife and civil aircraft occurred on or near airports when aircraft are below 2,000 feet above ground level (AGL). Collisions with wildlife at these altitudes are especially dangerous as aircraft pilots have minimal time to recover from such emergencies.

Databases managed by FAA and the United States Air Force show that more than 54,000 civil and military aircraft sustained reported strikes with wildlife from 1990 to 1999 (28,150 civil strikes and 25,853 military strikes). Between 1990-1999, aircraft-wildlife strikes involving U. S. civil aircraft result in over $350 million/year worth of aircraft damage and associated losses and over 460,000 hours/year of aircraft down time.

From 1990 to 1999, waterfowl, gulls and raptors were involved in 77% of the 2,119 reported damaging aircraft-wildlife strikes where the bird was identified. Populations of Canada geese and many species of gulls and raptors have increased markedly over the last several years. Further, gulls and Canada geese have adapted to urban and suburban environments and, along with raptors and turkey vultures, are commonly found feeding or loafing on or near landfills.

In light of increasing bird populations and aircraft operations, the FAA believes locating landfills in proximity to airports increases the risk of collisions between birds and aircraft. To address this concern, the FAA issued AC 150/5200-33, *Hazardous Wildlife Attractions On or Near Airports*, to provide airport operators and aviation planners with guidance on minimizing wildlife attractant. AC 150/5200-33 recommends against locating municipal solid waste landfills within five statute miles of an airport if the landfill may cause hazardous wildlife to move into or through the airport's approach or departure airspace.

6. General. Using guidance provided in the following sections, persons considering construction or establishment of a landfill should first determine if the proposed facility meets the definition of a new MSWLF (see Appendix 1). Section 44718(d), as amended, applies only to a new MSWLF. It does not apply to the expansion or modification of an existing MSWLF, and does not apply in the State of Alaska. If the proposed landfill meets the definition of a new MSWLF, its proximity to certain public airports (meeting the criteria specified in Paragraph 8 below) should be determined. If it is determined that a new MSWLF would be located within six miles of such a public airport, then either the MSWLF should be planned for an alternate location more than 6 miles from the airport, or the MSWLF proponent should request the appropriate State aviation agency to file a petition for an exemption from the statutory restriction.

In addition to the requirements of § 44718(d), existing landfill restrictions contained in AC 150/5200-33, *Hazardous Wildlife Attractions On or Near Airports* (see Paragraph 5, Background) also may be applicable. Airport operators that have accepted Federal funds have obligations under Federal grant assurances to operate their facilities in safe manner and must comply with standards prescribed in advisory circulars, including landfill site limitations contained in AC 150/5200-33.

7. Landfills Covered by the Statute. The limitations of § 44718(d), as amended, only apply to a new MSWLF (constructed or established after April 5, 2000). The statutory limitations are not applicable where construction or establishment of a MSWLF began on or before April 5, 2000, or to an existing MSWLF (received putrescible waste on or before April 5, 2000). Further, an existing MSWLF that is expanded or modified after April 5, 2000, would not be held to the limitations of § 44718(d), as amended.

8. Airports Covered by the Statute. The statutory limitations restricting the location of a new MSWLF near an airport apply to only those airports that are recipients of Federal grants (under the Airport and Airway Improvement Act of 1982, as amended, 49 U.S.C. § 47101, *et se*q.) and to those that primarily serve general aviation aircraft and scheduled air carrier operations using aircraft with less than 60 passenger seats.

While the FAA does not classify airports precisely in this manner, the FAA does categorize airports by the type of aircraft operations served and number of annual passenger enplanements. In particular, the FAA categorizes public airports that serve air carrier operations. These airports are known as commercial service airports, and receive scheduled passenger service and have 2,500 or more enplaned passengers per year.

One sub-category of commercial service airports, nonhub primary airports, closely matches the statute requirement. Nonhub primary airports are defined as commercial service airports that enplane less than 0.05 percent of all commercial passenger enplanements (0.05 percent equated to 328,344 enplanements in 1998) but more than 10,000 annual enplanements. While these enplanements consist of both large and small air carrier operations, most are conducted in aircraft with less than 60 seats. These airports also are heavily used by general aviation aircraft, with an average of 81 based aircraft per nonhub primary airport.

In addition, the FAA categorizes airports that enplane 2,500 to 10,000 passengers annually as non-primary commercial service airports, and those airports that enplane

2,500 or less passengers annually as general aviation airports. Both types of airports are mainly used by general aviation but in some instances, they have annual enplanements that consist of scheduled air carrier operations conducted in aircraft with less than 60 seats. Of the non-primary commercial service airports and general aviation airports, only those that have scheduled air carrier operations conducted in aircraft with less than 60 seats would be covered by the statute. The statute does not apply to those airports that serve only general aviation aircraft operations.

To comply with the intent of the statute, the FAA has identified those airports classified as nonhub primary, non-primary commercial service and general aviation airports that:

1. Are recipients of Federal grant under 49 U.S.C. § 47101, et. seq.;

2. Are under control of a public agency;

3. Serve some scheduled air carrier operations conducted in aircraft with less than 60 seats; and

4. Have total annual enplanements consisting of at least 51% of scheduled air carrier enplanements conducted in aircraft with less than 60 passenger seats.

Persons considering construction or establishment of a new MSWLF should contact the FAA to determine if an airport within six statute miles of the new MSWLF meets these criteria (see paragraph 11 below for information on contacting the FAA). If the FAA determines the airport does meet these criteria, then § 44718(d), as amended, is applicable.

An in-depth explanation of how the FAA collects and categorizes airport data is available in the FAA's National Plan of Integrated Airport Systems (NPIAS). This report and a list of airports classified as nonhub primary, non-primary commercial service and general aviation airports (and associated enplanement data) are available on the FAA's Airports web site at http://www.faa.gov/arp/410home.htm.

9. Separation distance measurements. Section 44718(d), as amended, requires a minimum separation distance of six statute miles between a new MSWLF and a public airport. In determining this distance separation, measurements should be made from the closest point of the airport property boundary to the closest point of the MSWLF property boundary. Measurements can be made from a perimeter fence if the fence is co-located, or within close proximity to, property boundaries. It is the responsibility of the new MSWLF proponent to determine the separation distance.

10. Exemption Process. Under § 44718(d), as amended, the FAA Administrator may approve an exemption from the statute's landfill location limitations. Section 44718(d), as amended, permits the aviation agency of the state in which the airport is located to request such an exemption from the FAA Administrator. Any person desiring such an exemption should contact the aviation agency in the state in which the affected airport is located. A list of state aviation agencies and contact information is available at the National Association of State Aviation Officials (NASAO) web site at www.nasao.org or by calling NASAO at (301) 588-1286.

A state aviation agency that desires to petition the FAA for an exemption should notify the Regional Airports Division Manager, in writing, at least 60 days prior to the establishment or construction of a MSWLF. The petition should explain the nature and extent of relief sought, and contain information, documentation, views, or arguments that demonstrate that an exemption from the statute would not have an adverse impact on aviation safety. Information on contacting FAA Regional Airports Division Managers can be found on the FAA's web site at www.faa.gov.

After considering all relevant material presented, the Regional Airports Division Manager will notify the state agency within 30 days whether the request for exemption has been approved or denied. The FAA may approve a request for an exemption if it is determined that such an exemption would have no adverse impact on aviation safety.

11. Information. For further information, please contact the FAA's Office of Airport Safety and Standards, Airport Safety and Certification Branch, at (800) 842-8736, Ext. 73085 or via email at WebmasterARP@faa.gov. Any information, documents and reports that are available on the FAA web site also can be obtained by calling the toll-free telephone number listed above.

DAVID L. BENNETT

Director, Office of Airport Safety and Standards

APPENDIX 1. DEFINITIONS.

The following are definitions for the specific purpose of this advisory circular.

a. Construct a municipal solid waste landfill (MSWLF) means excavate or grade land, or raise structures, to prepare a municipal solid waste landfill as permitted by the appropriate regulatory or permitting authority.

b. Establish a municipal solid waste landfill (MSWLF) means receive the first load of putrescible waste on site for placement in a prepared municipal solid waste landfill.

c. Existing municipal solid waste landfill (MSWLF) means a municipal solid waste landfill that received putrescible waste on or before April 5, 2000.

d. General aviation aircraft means any civil aviation aircraft not operating under 14 CFR Part 119, Certification: Air carriers and commercial operators.

e. Municipal solid waste landfill (MSWLF) means publicly or privately owned discrete area of land or an excavation that receives household waste, and that is not a land application unit, surface impoundment, injection well, or waste pile, as those terms are defined under 40 CFR § 257.2. A MSWLF may receive other types of RCRA subtitle D wastes, such as commercial solid waste, nonhazardous sludge, small quantity generator waste and industrial solid waste, as defined under 40 CFR § 258.2. A MSWLF may consist of either a standalone unit or several cells that receive household waste.

f. New municipal solid waste landfill (MSWLF) means a municipal solid waste landfill that was established or constructed after April 5, 2000.

g. Person(s) means an individual, firm, partnership, corporation, company, association, joint-stock association, or governmental entity. It includes a trustee, receiver, assignee, or similar representative of any of them (14 CFR Part 1).

h. Public agency means a State or political subdivision of a State; a tax-supported organization; or an Indian tribe or pueblo (49 U.S.C. § 47102(15)).

i. Public airport means an airport used or intended to be used for public purposes that is under the control of a public agency; and of which the area used or intended to be used for landing, taking off, or surface maneuvering of aircraft is publicly owned (49 U.S.C. § 47102(16)).

j. Putrescible waste means solid waste which contains organic matter capable of being decomposed by micro-organisms and of such a character and proportion as to be capable of attracting or providing food for birds (40 CFR § 257.3-8).

k. Scheduled air carrier operation means any common carriage passenger-carrying operation for compensation or hire conducted by an air carrier or commercial operator for 8/26/00 AC 150/5200-34 Appendix 17 which the air carrier, commercial operator, or their representatives offers in advance the departure location, departure time, and arrival location. It does not include any operation that is conducted as a supplemental operation under 14 CFR Part 119, or is conducted as a public charter operation under 14 CFR Part 380 (14 CFR § 119.3).

l. Solid waste means any garbage, or refuse, sludge from a wastewater treatment plant, water supply treatment plant, or air pollution control facility and other discarded material, including solid, liquid, semi-solid, or contained gaseous material resulting from industrial, commercial, mining, and agricultural operations, and from community activities, but does not include solid or dissolved materials in domestic sewage, or solid or dissolved materials in irrigation return flows or industrial discharges that are point sources subject to permit under 33 U.S.C. § 1342, or source, special nuclear, or by-product material as defined by the Atomic Energy Act of 1954, as amended (68 Stat. 923) (40 CFR § 258.2).

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AC 150/5300-13 Airport Design. Appendix 19. Minimum Distances Between Certain Airport Features And Any On-Airport Agriculture Crops.

Aircraft Approach Category And Design Group [1]	Distance In Feet From Runway Centerline To Crop		Distance In Feet From Runway End To Crop		Distance In Feet from Centerline Of Taxiway To Crop	Distance In Feet from Edge Of Apron To Crop
	Visual & ≥ ¾ mile	< ¾ mile	Visual & ≥ ¾ mile	< ¾ mile		
Category A & B Aircraft						
Group I	200 [2]	400	300[3]	600	45	40
Group II	250	400	400[3]	600	66	53
Group III	400	400	600	300	93	31
Group IV	400	400	1,000	1,000	130	113
Category C, D & E Aircraft						
Group I	530[3]	575[3]	1,000	1,000	45	40
Group II	530[3]	5753	1,000	1,000	66	53
Group III	530[3]	5753	1,000	1,000	93	31
Group IV	530[3]	5753	1,000	1,000	130	113
Group V	530[3]	5753	1,000	1,000	160	133
Group VI	530[3]	5753	1,000	1,000	193	167

[1] Design Groups are based on wing span, and Category depends on approach speed of the aircraft.

Group I: Wing span up to 49 ft.	Category A:	Speed less than 91 knots
Group II Wing span 49ft. up to 73 ft.	Category B:	Speed 91 knots up to 120 knots
Group III: Wing span 79 ft. up to 117 ft.	Category C:	Speed 121 knots up to 140 knots
Group IV: Wing span 113 ft. up to 170 ft.	Category D:	Speed 141 knots up to 165 knots
Group V: Wing span 171 ft. up to 213 ft.	Category E:	Speed 166 knots or more
Group VI: Wing span 214 ft. up to 261 ft.		

[2] If the runway will only serve small airplanes (12,500 lb. And under) in Design Group I, this dimension may be reduced to 125 feet; however, this dimension should be increased where necessary to accommodate visual navigational aids that may be installed. For example farming operations should not be allowed within 25 feet of a Precision Approach Path Indicator (PAPI) light box.

[3] These dimensions reflect the TSS as defined in AC 150/5300-13, Appendix 2. The TSS cannot be penetrated by any object. Under these conditions, the TSS is more restrictive than the OFA, and the dimensions shown here are to prevent penetration of the TSS by crops and farm machinery.

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APPENDIX D:
FAA, Office Of Airport Safety And Standards, Program Policies And Guidance — Airport Certification Program – 14 CFR 139

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Airport Certification Program – 14 CFR 139
Program Policy And Guidance

Policy No. 77: Initiation of Wildlife Hazard Assessments at Airports

14 CFR 139.337	June 21, 2004

SUBJECT :

Initiation of Wildlife Hazard Assessments at Airports.

CANCELLATION:

Program Policy and Guidance Policy Number 53, Initiation of Wildlife Hazard Assessments at Airports, Issued April 25, 1997 is cancelled.

PURPOSE:

This policy establishes the procedures Federal Aviation Administration (FAA) Airport Certification Safety Inspectors (ACSI) should follow when it is determined that an airport needs to conduct a wildlife hazard assessment to address an airport wildlife hazard.

BACKGROUND:

Populations of wildlife species commonly associated with wildlife/aircraft strikes are increasing at a marked rate in the United States. For example, the resident Canada goose population quadrupled between 1986 and 2002; white-tailed deer populations increased from 350,000 in 1900 to over 26 million in 2000; and ring-billed gull populations increased 4-fold between 1966 and 1999. The presence of wildlife on and near airports creates a hazard to operating aircraft.

Wildlife/aircraft strikes cause severe damage to operating aircraft, human injuries and loss of life. It is estimated that between 1990 and 2002, wildlife strikes cost U. S. civil aviation over $500 million annually.

Title 14, Code of Federal Regulations, part 139.337 requires the certificate holder to conduct a wildlife hazard assessment, acceptable to the FAA, when a wildlife hazard exist on the airport. This study is used by the FAA to determine if a wildlife hazard management plan is needed for the airport. A Memorandum of Understanding (MOU) between the FAA and USDA Wildlife Services (No. 12-34-71-0003-MOU) establishes a cooperative relationship between these agencies for resolving wildlife hazards to aviation. The FAA relies heavily on the assistance of Wildlife Services to conduct, review, or contribute to, airport wildlife hazard assessments and airport wildlife hazard management plans.

PROCEDURES:

When the FAA determines that a wildlife hazard assessment is needed for a particular airport, the ACSI should:

Contact the appropriate airport official and inform them of the need for the study.

The certificate holder may look to ADC or to a private party to conduct the required wildlife hazard assessment. The certificate holder is responsible for consultant selection and initial contact. Because the wildlife hazard assessment is used by the FAA to determine if a wildlife hazard management plan is needed for the airport, it should be conducted by persons having the education, training, and experience necessary to adequately assess any wildlife hazards.

Give the airport sufficient time (normally no more than 30 days) to make the initial contact and set a date when the study will begin.

Review the airport's certification manual (ACM) to determine what procedures are already in place to meet section 139.337 requirements and the degree of compliance on the part of the airport. Failure of the certificate holder to fully comply with all part 139 requirements is a violation of the regulation.

Take follow-up actions as needed to insure timely initiation and completion of the study, as well as submission of the study results and recommendations.

Review the study and recommendations to determine if an airport wildlife hazard management plan is needed. Upon completion of the review process, convey the determination to the certificate holder.

OSB	June 21, 2004
Ben Castellano, Manager Airport Safety & Operations Division	Date

Airport Certification Program – 14 CFR 139
Program Policy And Guidance

Policy No. 78:
Section 7 Consultation on Endangered or Threatened Species

14 CFR 139.337	June 21, 2004

SUBJECT:

Section 7 Consultation on Endangered or Threatened Species.

CANCELLATION:

Program Policy and Guidance Policy Number 57, Section 7 Consultation on Endangered or Threatened Species. Issued March 19, 1998 is cancelled.

PURPOSE:

This policy establishes the procedures for coordinating and documenting Federal Aviation Administration (FAA) compliance with the Endangered Species Act when requiring an airport operator to develop, submit for approval, and implement a Wildlife Hazard Management Plan.

BACKGROUND:

Section 7(a)(2) of the Endangered Species Act of 1973, as amended, (16 U.S.C. 1531 *et seq.*) states, in part, that each Federal agency shall, in consultation with and with the assistance of the Secretary of Interior, insure that any action authorized, funded, or carried out by such agency is not likely to jeopardize the continued existence of any Federally-listed or proposed endangered or threatened species, or result in the destruction or adverse modification of designated or proposed critical habitat.

The FAA's action in requiring an airport operator to develop, submit for approval, and implement a Wildlife Hazard Management Plan is considered a Federal action, as defined in the Endangered Species Act, and therefore, subject to section 7 consultation with the U.S. Fish and Wildlife Service (USFWS).

PROCEDURES:

Under Title 14, Code of Federal Regulations, part 139.337(e), the FAA may direct an airport operator to develop a Wildlife Hazard Management Plan or to update an existing plan. In these instances, the FAA Regional Coordinator (usually the Airport Certification Safety Inspector responsible for wildlife hazards) shall contact and request information from the local USFWS Ecological Services Field Office regarding the presence of Federally-listed or proposed species or designated or proposed critical habitat occurring on or near the airport. Form letter #1 (attached) shall be used to make this request.

NO FURTHER COORDINATION IS REQUIRED.

If the USFWS indicates there are no Federally-listed or proposed species or designated or proposed critical habitat occurring on or near the airport, no further action is required regarding the section 7 consultation.

FURTHER COORDINATION IS REQUIRED.

If the USFWS indicates that Federally-listed or proposed species or designated or proposed critical habitat occur on or near the airport, the following additional actions must be taken.

1) The FAA Regional Coordinator shall forward the information regarding the presence of Federally-listed or proposed species or designated or proposed critical habitat to the airport so it can take this information into consideration when developing its Wildlife Hazard Management Plan.

a) The airport operator must prepare a Biological Assessment (50 CFR 402.13) assessing the affects of the Wildlife Hazard Management Plan on the Federally-listed or proposed species or designated or proposed critical habitat. The Biological Assessment must be submitted to FAA along with the draft plan.

b) The airport operator may request early consultation if it has reasons to believe some of the actions proposed under the Wildlife Hazard Management Plan may affect Federally-listed or proposed species or designated or proposed critical habitat.

2) When the plan is submitted to the FAA for review and approval, the FAA Regional Coordinator must contact the local USFWS Ecological Services Field Office responsible for section 7 consultations and request consultation on the plan. Form letter #2 (attached) shall be used to submit the Wildlife Hazard Management Plan to USFWS ES for section-7 consultation.

3) The section-7 consultation must be completed before the Wildlife Hazard Management Plan is given final FAA approval and returned to the airport operator for inclusion in its Airport Certification Manual and implementation.

4) The signature level for both letters is at the discretion of the FAA Regional Office.

OSB	June 21, 2004
Ben Castellano, Manager Airport Safety & Operations Division	Date

FORM LETTER #1

Request for information regarding the presence of Federally-listed or proposed species or designated or proposed critical habitat.

Because of recent wildlife aircraft strikes at __________ Airport in ______County, ____(State), the Federal Aviation Administration (FAA) is requiring the airport develop a Wildlife Hazard Management Plan to reduce the wildlife aircraft strike hazard at the airport.

As part of the Wildlife Hazard Management Plan developmental process, potential impact on federally-listed or proposed species or designated or proposed critical habitat will be considered. Therefore, would you provide information concerning the presence of federally-listed or proposed species or designated or proposed critical habitat occurring on or near the airport?

Please reply to the attention of _________, [and reference file no. ________].

Thank you for your cooperation in this matter.

FORM LETTER #2

Request for Section 7 Consultation.

At the direction of the Federal Aviation Administration (FAA), __________ Airport in ______County, ____(State), has developed the attached Wildlife Hazard Management Plan, which is intended to mitigate wildlife aircraft strike hazards at the airport.

The actions proposed in the plan may include:

Habitat modifications - reduction/elimination of food, cover, and water attractive to certain wildlife species.

Resource protection - repelling of certain wildlife species using physical barriers and/or chemical, audio, and/or visual repellents.

Population management - removal of certain wildlife species from the vicinity of the airport using non-lethal and lethal means.

In accordance with Section 7 of the Endangered Species Act of 1973, as amended, the FAA has reviewed the draft plan and has determined that the plan is/is not *(select one; consult the FAA Staff Wildlife Biologist if assistance is needed in making the determination of effect.)* likely to adversely affect the following federally-listed or proposed species or designated or proposed critical habitat: *(list federally-listed or proposed species or designated or proposed critical habitat from information provided by USFWS ES, in response to form letter #1).*

Please reply to the attention of _________, [and reference file no. ________].

Thank you for your cooperation in this matter.

Airport Certification Program - 14 CFR 139
Program Policy And Guidance

Policy No. 79: Review of Airport Wildlife Hazard Management Plans

14 CFR 139.337	June 21, 2004

SUBJECT:

Review of Airport Wildlife Hazard Management Plans.

CANCELLATION:

Program Policy and Guidance Policy Number 64, Review of Airport Wildlife Hazard Management Plans, Issued October 4, 1999 is cancelled.

PURPOSE:

This policy establishes procedures Airport Certification Safety Inspectors must follow when an incident occurs that requires an operator of a certificated airport to initiate a Wildlife Hazard Assessment, as mandated under Title 14, Code of Federal Regulations, §139.337(b)(1-4).

BACKGROUND:

Part 139.337 prescribes action that a certificate holder must take in response to certain wildlife events. As a reminder, the requirements states:

(b) In a manner authorized by the Administrator, each certificate holder shall ensure that a Wildlife Hazard Assessment is conducted when any of the following events occurs on or near the airport:

(1) An air carrier aircraft experiences multiple wildlife strikes;

(2) An air carrier aircraft experiences substantial damage from striking wildlife. 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 (b)(1), (b)(2), or (b)(3) of this section is observed to have access to any airport flight pattern or aircraft movement area.

Recent strike reports received by the Airport Safety and Certification Branch (AAS-310) have raised questions regarding compliance with the standards of §139.337. To resolve this matter, Airport Certification Safety Inspectors shall implement the following procedures when notified of any of the events listed in §139.337 (b)(1-4). These procedures are intended to ensure that certificate holders take appropriate action in response to wildlife strikes/incidents and that the FAA consistently maintains records of actions taken.

PROCEDURES:

AAS-310 will review all reports of aircraft wildlife strikes. When a strike is reported that would initiate a Wildlife Hazard Assessment under §139.337(b)(1-4), a copy of the report, together with the strike history of the airport in question, will be forwarded to the Regional Coordinator, usually the Airport Certification Safety Inspector responsible for that region's wildlife hazard management issues.

When notification is received from AAS-310, the Regional Coordinator will review the specific airport's Airport Certification Manual to determine if a Wildlife Hazard Assessment has ever been conducted at the airport, and if the results of that study led to the development and implementation of an FAA approved Wildlife Hazard Management Plan.

If a Wildlife Hazard Assessment has never been conducted, the Regional Coordinator will instruct the certificate holder to undertake the required Wildlife Hazard Assessment. Procedures found in Program Policy and Guidance Policy # 53, Initiation of Wildlife Hazard Assessments at Airports should be followed. The results of this study, together with other pertinent factors, will be used to determine if a Wildlife Hazard Management Plan is needed.

If a Wildlife Hazard Assessment was conducted within the last 12 months, but development and implementation of a Wildlife Hazard Management Plan was not required, Regional Coordinator will review the Wildlife Hazard Assessment and the decision not to require development and implementation of a Wildlife Hazard Management Plan. In most cases, the certificate holder should be instructed to develop and submit for FAA approval, a Wildlife Hazard Management Plan, based on the results of the Wildlife Hazard Assessment.

If the Wildlife Hazard Assessment is more than 12 months old, and no Wildlife Hazard Management Plan was developed, the Regional Coordinator will instruct the certificate holder to begin a new Wildlife Hazard Assessment. The results of this study, together with other pertinent factors, will be used to determine if a Wildlife Hazard Management Plan is needed.

If a FAA approved Wildlife Hazard Management Plan is in place; the Plan should be reviewed to insure that it meets all requirements of §139.337(f). Certalert 97-09, Wildlife Hazard Management Plan Outline provides guidance on what should be in an airport's Wildlife Hazard Management Plan.

If the Wildlife Hazard Management Plan does not meet all requirements of §139.337(f), the Regional Coordinator will instruct the certificate holder to bring the Plan into compliance with §139.337(f). In some cases, it may be necessary for the certificate holder to under take a new Wildlife Hazard Assessment.

If the Wildlife Hazard Management Plan does meet all requirements of §139.337(f), the

Regional Coordinator will instruct the certificate holder to review the Plan and determine if it needs revision. This review is best conducted with the assistance of a Wildlife Damage Management Biologist.

Following the review, the certificate holder must notify the FAA of the results of their review and any proposed corrective actions or changes to their Wildlife Hazard Management Plan. When approved, amendments shall be incorporated in the Airport Certification Manual.

As a reminder, Airport Certification Safety Inspectors will, as part of the initial or periodic inspection, review an airport's Wildlife Hazard Management Plan to ensure that is meets all requirements of §139.337(f)

Further, Airport Certification Safety Inspectors will also review remarks on wildlife hazards in the Airport Facility Directory (AFD), Notice to Airmen (NOTAM) system, or the Automatic Terminal Information Service (ATIS). If these remarks warn of wildlife hazards at or around the airport, the Airport Certification Safety Inspector will consider such remarks to have met the criteria of §139.337(b)(4), and therefore will require the certificate holder to conduct a Wildlife Hazard Assessment, if such a study has not been previously conducted. The results of the Wildlife Hazard Assessment will be used to determine if a Wildlife Hazard Management Plan is needed.

OSB	June 21, 2004
Ben Castellano, Manager Airport Safety & Operations Division	Date

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Airport Certification Program – 14 CFR Part 139
Program Policy And Guidance

Policy No. 82 Waste Disposal Facility Coordination

14 CFR 139.337	September 9, 2004

SUBJECT:

Waste Disposal Facility Coordination.

CANCELLATION:

Program Policy and Guidance Policy Number 65, Waste Disposal Facility Coordination, Issued October 4, 1999 is cancelled.

PURPOSE:

This policy establishes the procedures for coordinating and documenting Federal Aviation Administration (FAA) determinations on developing new or expanding existing waste disposal sites within 5 miles of a public-use airport. Guidance on siting various types of landfills is provided in FAA Advisory Circular 150/5200-33A — *Hazardous Wildlife Attractants on or Near Airports*, and FAA Advisory Circular 150/5200-34 — *Construction Or Establishment Of Landfills Near Public Airports*.

BACKGROUND:

The increasing pressure to develop new or expand existing waste disposal sites necessitates coordinating responses to ensure that the agency has a consistent response to these proposals. This practice has been in effect in the Great Lakes and Southwest Regions for several years and has worked well.

PROCEDURES:

When a landfill proponent notifies FAA under Title 40, Code of Federal Regulations, part 258.10, of a proposal to establish a new or expand an existing landfill, the Regional Coordinator, usually the Airport Certification Safety Inspector (ACSI), responsible for waste disposal and wildlife hazards in that region will:

Evaluate the proposal and determine whether on not it is compatible with the provisions of AC 150/5200 – 33A, AC 150/5200 – 34, and safe airport operations;

Complete a copy of the attached Waste Disposal Facility Coordination Form, based on that determination, including any recommended permitting conditions;

Forward the completed form, together with any supporting material to the FAA Staff Wildlife Biologist (AAS-300) for evaluation and coordination.

If the potentially affected airport is a joint use facility with military aviation, a courtesy copy of the completed form, together with any supporting material should be forwarded to the FAA regional military liaison.

Any disagreement between the recommendations of the Regional Coordinator and the Staff Wildlife Biologist will be resolved by consultation between the Region and Headquarters. When agreement is reached, the Staff Wildlife Biologist will sign the Coordination Form and return a copy to the Regional Coordinator.

All applicable recommended permitting conditions (Section 4 of the Waste Disposal Facility Coordination Form) should be included in the Letter of Determination sent to the proponent or state agency. The completed form will be made a part of the region's permanent file.

OSB	September 9, 2004
Ben Castellano, Manager Airport Safety & Operations Division	Date

EXAMPLE WASTE DISPOSAL/PROCESSING FACILITY (WD/WP) COORDINATION FORM

SECTION 1 – WASTE DISPOSAL/PROCESSING FACILITY (WD/WP) INFORMATION

Site / Facility Name:	File No
Associated City / State:	

Check as appropriate

New Site:	Expand/Modify Existing Site:	Re-Permit Existing Site:	Other:
Sanitary Landfill:	Waste transfer Station:	Demolition/Construction Debris:	Recycling Center:
Compost:	Water Treatment/Oxidation:	Water Detention/Retention:	Other:

Circle as appropriate

Facility will process or store putrescible waste material outdoors::	Y - N
Facility is within 5,000 feet of a public-use airport utilized by piston engine aircraft:	Y - N
Facility is within 10.000 feet of a public-use airport utilized by turbine engine aircraft:	Y - N

Facility is within a 5 mile radius of a public-use airport:	Y - N	Distance to nearest runway end (FT):	
Reported hazardous wildlife activity at airport:	Y - N	Reported hazardous wildlife activity at facility:	Y - N
State EPA licensing requirements:	Y - N	State EPA enforcement/mitigation procedures:	Y - N
USDA/WS evaluation conducted:	Y - N	Non-hazard: _____ Hazard: _____	(check one)

SECTION 2 - AIRPORT INFORMATION

Associated Public Use Airports:

LOC ID:	ATCT: Y - N	Military Aviation On-Site: Y - N (If yes, notify FAA regional military liaison)	
Type Airport: GA - Com Serv	Longest Runway (Ft):	Instrument Runway: Y - N	Jet fuel Available: Y - N
Total Annual Operations:	Piston Operations:	Turbine Operations:	

SECTIONS 3 – COMPATIBILITY

Proposed wildlife attraction is considered compatible with provisions of FAA AC 150/5200-33

Concur:	Non-concur:	Signature:	Date:
Supporting documentation, correspondence, site maps, etc., attached			
AAS-300 agree:	Disagree:	Signature:	Date:

SECTIONS 4 – CONDITIONS FOR CONCURRENCE

_____	1	The WD/PF must be properly supervised to assure that bird populations are not increasing and that appropriate control procedures are being followed.
_____	2	Any increases in bird activity that might be hazardous to safe aircraft operations will result in prompt mitigation actions and/or closure of the WD/PF.
_____	3	Garbage shall not be handled or stored outside the WD/PF at any time, for any reason, or in a partially enclosed vehicle/structure that is accessible to birds or other wildlife.
_____	4	The WD/PF shall be totally enclosed and shall be operated without any outward indications that waste disposal operations are underway indoors.
_____	5	Only non-putrescible demolition/construction waste material will be accepted in the WD/PF.
_____	6	Only composting materials shall be accepted in the referenced WD/PF. No other putrescible materials shall be accepted.
	7	The above checked conditions must be clearly defined via state/local licensing procedures associated with establishment of the WD/PF.

SECTIONS 5 – COMMENTS

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APPENDIX E:
FAA, Office Of Airport Safety And Standards, Certalerts

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CERTALERT

No. 98-05: Grasses Attractive To Hazardous Wildlife

ADVISORY CAUTIONARY NON-DIRECTIVE

FOR INFORMATION, CONTACT AIRPORT WILDLIFE SPECIALIST,
AAS-317 (202) 267.3389

DATE:	September, 18, 1998	No. 98-05
TO:	Airport Operators, FAA Airport Certification Safety Inspectors	
TOPIC:	Grasses Attractive to Hazardous Wildlife	

Recently, several reports have been received of airport owners or airport contractors planting disturbed areas (construction sites, re-grading projects, etc) with seed mixtures containing brown-top millet. All millets are a major attractant to doves and other seed eating birds.

Doves can be a major threat to aircraft safety. In the United States, between 1991 and 1997, doves were involved in 11% of all reported bird/aircraft strikes, 8% of the reported strikes that resulted in aircraft down time, and 8% of the reported strikes causing aircraft damage or other associated monetary losses.

Airport operators should ensure that grass species and other varieties of plants attractive to hazardous wildlife are not used on the airport. Disturbed areas or areas in need of re-vegetating should not be planted with seed mixtures containing millet or any other large-seed producing grass.

For airport property already planted with seed mixtures containing millet or other large-seed producing grasses, it is recommended that disking, plowing, or other suitable agricultural practice be employed to prevent plant maturation and seed head production.

For specific recommendations on grass management and seed selection, contact the State University Cooperative Extension Service, or the local office of the USDA, Wildlife Services.

OSB

Ben Castellano, Manager
Airport Safety & Operations Division

September 18, 1998

Date

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C E R T A L E R T

No. 04-09: Relationship Between FAA And WS

ADVISORY CAUTIONARY NON-DIRECTIVE

FOR INFORMATION, CONTACT AIRPORT WILDLIFE SPECIALIST,
AAS-317 (202) 267.3389

DATE:	August 30, 2004	No. 04-09
TO:	Airport Certification Program Inspectors	
TOPIC:	Relationship Between FAA And WS	

CANCELLATION:

Certalert 97-02, Relationship Between FAA And WS, Dated April 25, 1997, is cancelled.

PURPOSE:

This Certalert clarifies the roles of, and relationship between the Federal Aviation Administration (FAA) and the United States Department of Agriculture/Animal and Plant Health Inspection Service/Wildlife Services (WS) with regards to wildlife hazards on or near airports.

FEDERAL AVIATION ADMINISTRATION

The FAA issues airport operating certificates for airports serving certain air carrier aircraft under Title 14, Code of Federal Regulations, Part 139. Section 139.337 requires certificated airports having a wildlife hazard problem to develop and implement a Wildlife Hazard Management Plan to manage and control wildlife, which present a risk to public safety, caused by aircraft collisions with wildlife. The FAA relies heavily on the assistance of WS to review and contribute to such plans.

ANIMAL DAMAGE CONTROL

The Animal Damage Control Act of March 2, 1931, (7 USC 426-426c, as amended), charges the Secretary of Agriculture with management of wildlife injurious to agricultural interests, other wildlife, or human health and safety. Further, the Secretary is authorized to cooperate with States, individuals, public and private agencies, organizations, and institutions in the control of nuisance mammals and birds, including wildlife hazards to aviation. Because of the experience, training, and background of its personnel, WS is recognized throughout the world as an expert in dealing with wildlife damage management issues. WS has an active presence in all U.S. states and territories.

MEMORANDUM OF UNDERSTANDING

A Memorandum of Understanding (MOU) between the FAA and WS (No. 12-4-71-0003-MOU) establishes a cooperative relationship between these agencies for resolving wildlife hazards to aviation.

AGENCY FUNDING

Both agencies are funded by congressional appropriations. The majority of funding for the FAA comes from the Aviation Trust Fund with the remainder coming from the general funds of the U.S. Treasury. Any revenues generated by the FAA are returned to the U.S. Treasury. WS receives a limited amount of funds from the general fund of the U.S. Treasury that allows it to perform some services for the public good. However, WS's funding is also based upon its ability to enter into contracts to provide services and receive reimbursement for the cost of the services. Legislation allows WS to collect this money and return it to the program rather than the general funds of the U.S. Treasury. Consequently, WS may enter into a cooperative service agreement with an airport operator for reimbursement of services to perform a wildlife hazard assessment on an airport.

WILDLIFE HAZARD MANAGEMENT

14 CFR 139.337(b) requires the certificate holder conduct a wildlife hazard assessment, acceptable to the FAA Administrator, when any of the following events occur on or near the airport:

(b) (1) An air carrier aircraft experiences multiple wildlife strikes:

(b) (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;

(b) (3) An air carrier aircraft experiences an engine ingestion of wildlife; or

(b) (4) Wildlife of a size, or in numbers, capable of causing an event described in paragraph (b)(1), (2), or (3) of this section is observed to have access to any airport flight pattern or aircraft movement area.

The wildlife hazard assessment shall contain at least the following (14CFR 139.337(c)):

(c) (l) An analysis of the events or circumstances that prompted the assessment.

(c) (2) Identification of the wildlife species observed and their numbers, locations, local movements, and daily and seasonal occurrences.

(c) (3) Identification and location of features on and near the airport that attract wildlife.

(c) (4) A description of wildlife hazards to air carrier operations.

(c) (5) Recommended actions for reducing identified wildlife hazards to air carrier operations.

The certificate holder may look to WS or to private consultants to conduct the required wildlife hazard assessment. The FAA uses the wildlife hazard assessment in determining if a wildlife hazard management plan is needed for the airport. Therefore, persons having the education, training, and experience necessary to adequately assess any wildlife hazards should conduct the assessment.

Depending on the availability of resources, WS may conduct a preliminary hazard assessment at no charge to the certificate holder. The certificate holder should determine in advance if WS will charge to conduct the preliminary hazard assessment. More detailed assessments may require the certificate holder to enter into a cooperative service agreement with WS.

OSB	August 30, 2004
Ben Castellano, Manager Airport Safety & Operations Division	Date

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C E R T A L E R T

No. 04-16: Deer Hazard to Aircraft and Deer Fencing

ADVISORY CAUTIONARY NON-DIRECTIVE

FOR INFORMATION, CONTACT AIRPORT WILDLIFE SPECIALIST,
AAS-317 (202) 267.3389

DATE:	December 13, 2004	No. 04-16
TO:	Airport Operators, FAA Airport Certification Program Inspectors	
TOPIC:	Deer Hazard to Aircraft and Deer Fencing	

CANCELLATION:

Certalert 01-01. Deer Aircraft Hazard, dated February 1, 2001; and Certalert 02-09. Alternative Deer Fencing, dated December 12, 2002, are cancelled.

BACKGROUND

Elevated deer populations in the United States represent an increasingly serious threat to both Commercial and General Aviation Aircraft. It is currently estimated that there over 26 million deer in the United States. Because of increasing urbanization and rapidly expanding deer populations, deer are adapting to human environments, especially around airports, where they often find food and shelter. From 1990 to 2004, over 650 deer-aircraft collisions were reported to the Federal Aviation Administration (FAA). Of these reports, over 500 indicated the aircraft was damaged as a result of the collision.

In light of recent incidents where a Learjet landing at an airport in Alabama and a Learjet departing an airport in Oregon were destroyed after colliding with deer or elk, airport operators are reminded of the importance of controlling deer and other wild ungulates on and around airfields.

PURPOSE

Proper fencing is the best way of keeping deer off aircraft movement areas. The FAA recommends a 10-12 foot chain link fence with 3-strand barbed wire outriggers. In some cases an airport may be able to use an 8-foot chain link fence with 3-strand barbed outriggers, depending upon the amount of deer activity in a local area.

All fencing must be properly installed and maintained. A 4-foot skirt of chain-link fence material, attached to the bottom of the fence and buried at a 45^{o} angle on the outside of the fence will prevent animals from digging under the fence and reduce the chance of washouts. This type of fencing also greatly increases airport security and safety. The fence line right-of-way must be kept free of excess vegetation. The fence line should be patrolled at least daily, and any washouts, breaks or other holes in the fence repaired as soon as they are discovered.

Gates should close with less than 6-inch gaps to prevent entry by deer.

When installation of chain link fencing is not feasible due to cost or environmental impacts, other types of fencing may be installed. (Cost alone is not an acceptable reason for rejecting the use of chain link fencing.) In some cases, electric fencing may offer a suitable alternative. Recent improvements in fencing components and design have greatly increased the effectiveness and ease of installation of electric fences. Tests by the USDA, National Wildlife Research Center have shown that some 4 to 6-foot, 5 to 9-strand electric fences designs can be 99% effective at stopping deer. Installation of some of the newer electric fences requires neither specialized equipment nor training and can be accomplished by airport personnel.

In limited situations, the use of non-conductive, composite, frangible electric fence posts and fence conductors may allow the installation of electric fence closer to the aircraft movement area than would normally be allowed with standard chain link fencing material.

If deer are observed on or near the aircraft movement area, immediate action must be taken to remove them.

Airport operators can contact the nearest USDA, Wildlife Services Office or the State Wildlife Management Agency for assistance with deer problems.

OSB	December 13, 2004
Ben Castellano Manager Airport Safety & Operations Division	Date

APPENDIX F:
USDA, Wildlife Services Directive 2.305
Wildlife Hazards To Aviation

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United States Department of Agriculture
Animal and Plant Health Inspection Service
Wildlife Services
Directive 2.305 4/15/98
Wildlife Hazards To Aviation

1. PURPOSE

To provide general guidelines for Wildlife Services (WS) technical and/or direct control assistance to airport managers, State aviation agencies, aviation industry, Federal Aviation Administration (FAA), and Department of Defense regarding hazards caused by wildlife to airport safety.

2. REPLACEMENT HIGHLIGHTS

This directive replaces ADC Directive 2.305 dated 04/05/95.

3. POLICY

WS will assist responsible Federal and State agencies, airport managers, and the aviation industry in reducing wildlife hazards to airports and air bases according to the APHIS/ADC [WS] Memorandum of Understanding with the FAA and the guidelines set forth in the WS Managing Wildlife Hazards at Airports Manual.

WS may enter into cooperative agreements to conduct wildlife hazard assessments and/or management plans for an airport or air base or to conduct direct control and/or technical assistance activities to minimize hazards caused by wildlife. These activities will be conducted under cooperative agreements fully funded by cooperating entities.

WS personnel may also provide specific training for airport and air base personnel in wildlife identification and the safe and proper use of wildlife damage management equipment and techniques. WS personnel will provide recommendations and assistance to airport managers and air base commanders in obtaining necessary Federal and State permits required to take protected wildlife species at airports and air bases.

Whenever WS personnel observe existing or potential wildlife hazards at airports or air bases, appropriate aviation authorities will be notified immediately.

4. REFERENCES

ADC Directive 2.620, ADC Aviation Safety and Operations
WS Managing Wildlife Hazards at Airports Manual
Memorandum of Understanding between APHIS and FAA (3/21/89)
14 CFR Part 139.337 Wildlife Hazard Management

Deputy Administrator

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APPENDIX G:
Memorandum Of Understanding
Between
United States Department Of Transportation,
Federal Aviation Administration
And
United States Department Of Agriculture,
Animal And Plant Health Inspection Service,
Wildlife Services.
(No. 12-34-71-0003-MOU)

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No. 12-34-71-0003-MOU

Memorandum of Understanding

between the

United States Department of Transportation

Federal Aviation Administration

and the

United States Department of Agriculture

Animal and Plant Health Inspection Service

Wildlife Services

ARTICLE 1

This Memorandum of Understanding (MOU) continues the cooperation between the Federal Aviation Administration and Wildlife Services (WS) for mitigating wildlife hazards to aviation.

ARTICLE 2

The FAA has the broad authority to regulate and develop civil aviation in the United States[1]. The FAA may issue Airport Operating Certificates to airports serving certain air carrier aircraft. Issuance of an Airport Operating Certificate indicates that the airport meets the requirements of Title 14, Code of Federal Regulations, part 139 (14 CFR 139) for conducting certain air carrier operations.

The WS has the authority to enter agreements with States, local jurisdictions, individuals, public and private agencies, organizations, and institutions for the control of nuisance wildlife[2]. The WS also has the authority to charge for services provided under such agreements and to deposit the funds collected into the accounts that incur the costs[3].

14 CFR 139.337 requires the holder of an Airport Operating Certificate (certificate holder) to conduct a wildlife hazard assessment (WHA) when specific events occur on or near the airport. A wildlife management biologist who has professional training

[1] Federal Aviation Act of 1958, 49 U.S.C. § 40101, et. seq.

[2] The Animal Damage Control Act of March 2, 1931, as amended, 46 Stat. 1468; 7 U.S.C. 426 – 426b.

[3] The Rural Development, Agriculture, and Related Agencies Appropriations Act of 1988, as amended, 426c to U.S.C. 426 – 426b.

and/or experience in wildlife hazard management at airports, or someone working under the direct supervision of such an individual, must conduct the WHA required by 14 CFR 139.337. The FAA reviews all WHAs to determine if the certificate holder must develop and implement a wildlife hazard management plan (WHMP) designed to mitigate wildlife hazards to aviation on or near the airport. These regulations also require airport personnel implementing an FAA-approved WHMP to receive training conducted by a qualified wildlife damage management biologist.

ARTICLE 3

The FAA and the WS agree to the following.

a. The WS has the professional expertise, airport experience, and training to provide support to assess and reduce wildlife hazards to aviation on and near airports. The WS can also provide the necessary training to airport personnel.

b. Most airports lack the technical expertise to identify underlying causes of wildlife hazard problems. They can control many of their wildlife problems following proper instruction in control techniques and wildlife species identification from qualified wildlife management biologists.

c. Situations arise where control of hazardous wildlife is necessary on and off airport property (i.e., roost relocations, reductions in nesting populations, and removal of wildlife). This often requires the specialized technical support of WS personnel.

d. The FAA or the certificate holder may seek technical support from WS to lessen wildlife hazards. This help may include, but is not limited to, conducting site visits and WHAs to identify hazardous wildlife, their daily and seasonal movement patterns and habitat requirements. WS personnel may also provide:

- i. support with developing WHMPs including recommendations on control and habitat management methods designed to minimize the presence of hazardous wildlife on or near the airport;
- ii. training in wildlife species identification and the use of control devices;
- iii. support with managing hazardous wildlife and associated habitats; and
- iv. recommendations on the scope of further studies necessary to identify and minimize wildlife hazards.

e. Unless specifically requested by the certificate holder, WS is not liable or responsible for development, approval, or implementation of a WHMP required by 14 CFR 139.337. Development of a WHMP is the responsibility of the certificate holder. The certificate holder will use the information developed by WS from site visits and/or conducting WHA in the preparation of a WHMP.

f. The FAA and WS agree to meet at least yearly to review this agreement, identify problems, exchange information on new control methods, identify research needs, and prioritize program needs.

ARTICLE 4

The WS personnel will advise the certificate holder of their responsibilities to secure necessary permits and/or licenses for control of wildlife. This will ensure all wildlife damage control activities are conducted under applicable Federal, State, and local laws and regulations.

ARTICLE 5

This MOU defines in general terms, the basis on which the parties will cooperate and does not constitute a financial obligation to serve as a basis for expenditures. Request for technical, operational, or research assistance that requires cooperative or reimbursable funding will be completed under a separate agreement.

ARTICLE 6

This MOU will supersede all existing MOUs, supplements, and amendments about the conduct of wildlife hazard control programs between WS and the FAA.

ARTICLE 7

Under Section 22, Title 41, U.S.C., no member of or delegate to Congress will be admitted to any share or part of this MOU or to any benefit to arise from it.

ARTICLE 8

This MOU will become effective on the date of final signature and will continue indefinitely. This MOU may be amended by agreement of the parties in writing. Either party, on 60 days advance written notice to the other party, may end the agreement.

___ OSB Woodie Woodward ___ Date _____ June 20, 2005 ______

Associate Administrator for Airports
Federal Aviation Administration

___ OSB William H Clay ___ Date _____ June 27, 2005 _____

Deputy Administrator for Wildlife Services
Animal and Plant Health Inspection Service

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APPENDIX H:
Memorandum of Agreement Between the Federal Aviation Administration, the U.S. Air Force, the U.S. Army, the U.S. Environmental Protection Agency, the U.S. Fish and Wildlife Service, and the U.S. Department of Agriculture to Address Aircraft-Wildlife Strikes

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Memorandum of Agreement Between the Federal Aviation Administration, the U.S. Air Force, the U.S. Army, the U.S. Environmental Protection Agency, the U.S. Fish and Wildlife Service, and the U.S. Department of Agriculture to Address Aircraft-Wildlife Strikes

PURPOSE

The signatory agencies know the risks that aircraft-wildlife strikes pose to safe aviation. This Memorandum of Agreement (MOA) acknowledges each signatory agency's respective missions. Through this MOA, the agencies establish procedures necessary to coordinate their missions to more effectively address existing and future environmental conditions contributing to aircraft-wildlife strikes throughout the United States. These efforts are intended to minimize wildlife risks to aviation and human safety, while protecting the Nation's valuable environmental resources.

BACKGROUND

Aircraft-wildlife strikes are the second leading causes of aviation-related fatalities. Globally, these strikes have killed over 400 people and destroyed more than 420 aircraft. While these extreme events are rare when compared to the millions of annual aircraft operations, the potential for catastrophic loss of human life resulting from one incident is substantial. The most recent accident demonstrating the grievous nature of these strikes occurred in September 1995, when a U.S. Air Force reconnaissance jet struck a flock of Canada geese during takeoff, killing all 24 people aboard.

The Federal Aviation Administration (FAA) and the United States Air Force (USAF) databases contain information on more than 54,000 United States civilian and military aircraft-wildlife strikes reported to them between 1990 and 1999[1]. During that decade, the FAA received reports indicating that aircraft-wildlife strikes, damaged 4,500 civilian U.S. aircraft (1,500 substantially), destroyed 19 aircraft, injured 91 people, and killed 6 people. Additionally, there were 216 incidents where birds struck two or more engines on civilian aircraft, with damage occurring to 26 percent of the 449 engines involved in these incidents. The FAA estimates that during the same decade, civilian U.S. aircraft sustained $4 billion worth of damages and associated losses and 4.7 million hours of aircraft downtime due to aircraft-wildlife strikes. For the same period, USAF planes colliding with wildlife resulted in 10 Class A Mishaps[2], 26 airmen deaths, and over $217 million in damages.

[1] FAA estimates that the 28,150 aircraft-wildlife strike reports it received represent less than 20% of the actual number of strikes that occurred during the decade.

[2] See glossary for the definition of a Class A Mishap and similar terms.

Approximately 97 percent of the reported civilian aircraft-wildlife strikes involved common, large-bodied birds or large flocks of small birds. Almost 70 percent of these events involved gulls, waterfowl, and raptors (Table 1).

About 90 percent of aircraft-wildlife strikes occur on or near airports, when aircraft are below altitudes of 2,000 feet. Aircraft-wildlife strikes at these elevations are especially dangerous because aircraft are moving at high speeds and are close to or on the ground. Aircrews are intently focused on complex take-off or landing procedures and monitoring the movements of other aircraft in the airport vicinity. Aircrew attention to these activities while at low altitudes often compromises their ability to successfully recover from unexpected collisions with wildlife and to deal with rapidly changing flight procedures. As a result, crews have minimal time and space to recover from aircraft-wildlife strikes.

Increasing bird and wildlife populations in urban and suburban areas near airports contribute to escalating aircraft-wildlife strike rates. FAA, USAF, and Wildlife Services (WS) experts expect the risks, frequencies, and potential severities of aircraft-wildlife strikes to increase during the next decade as the numbers of civilian and military aircraft operations grow to meet expanding transportation and military demands.

SECTION I.

SCOPE OF COOPERATION AND COORDINATION

Based on the preceding information and to achieve this MOA's purpose, the signatory agencies:

Agree to strongly encourage their respective regional and local offices, as appropriate, to develop interagency coordination procedures necessary to effectively and efficiently implement this MOA. Local procedures should clarify time frames and other general coordination guidelines.

Agree that the term "airport" applies only to those facilities as defined in the attached glossary.

Agree that the three major activities of most concern include, but are not limited to:

1. airport siting and expansion;
2. development of conservation/mitigation habitats or other land uses that could attract hazardous wildlife to airports or nearby areas; and
3. responses to known wildlife hazards or aircraft-wildlife strikes.

Agree that "hazardous wildlife" are those animals, identified to species and listed in FAA and USAF databases, that are most often involved in aircraft-wildlife strikes. Many of the species frequently inhabit areas on or near airports, cause structural damage to airport facilities, or attract other wildlife that pose an aircraft-wildlife strike hazard. Table 1 lists many of these species. It is included solely to provide information on identified wildlife species that have been involved in aircraft-wildlife strikes. It is not intended to represent the universe of species concerning the signatory agencies, since more than 50 percent of the aircraft-wildlife strikes reported to FAA or the USAF did not identify the species involved.

Agree to focus on habitats attractive to the species noted in Table 1, but the signatory agencies realize that it is imperative to recognize that wildlife hazard determinations discussed in Paragraph L of this section may involve other animals.

Agree that not all habitat types attract hazardous wildlife. The signatory agencies, during their consultative or decision making activities, will inform regional and local land use authorities of this MOA's purpose. The signatory agencies will consider regional, local, and site-specific factors (e.g., geographic setting and/or ecological concerns) when conducting these activities and will work cooperatively with the authorities as they develop and implement local land use programs under their respective jurisdictions. The signatory agencies will encourage these stakeholders to develop land uses within the siting criteria noted in Section 1-3 of FAA Advisory Circular (AC) 150.5200-33 (Attachment A) that do not attract hazardous wildlife. Conversely, the agencies will promote the establishment of land uses attractive to hazardous wildlife outside those siting criteria. Exceptions to the above siting criteria, as described in Section 2.4.b of the AC, will be considered because they typically involve habitats that provide unique ecological functions or values (e.g., critical habitat for federally-listed endangered or threatened species, ground water recharge).

Agree that wetlands provide many important ecological functions and values, including fish and wildlife habitats; flood protection; shoreline erosion control; water quality improvement; and recreational, educational, and research opportunities. To protect jurisdictional wetlands, Section 404 of the Clean Water Act (CWA) establishes a program to regulate dredge and/or fill activities in these wetlands and navigable waters. In recognizing Section 404 requirements and the Clean Water Action Plan's goal to annually increase the Nation's net wetland acreage by 100,000 acres through 2005, the signatory agencies agree to resolve aircraft-wildlife conflicts. They will do so by avoiding and minimizing wetland impacts to the maximum extent practicable, and will work to compensate for all associated unavoidable wetland impacts. The agencies agree to work with landowners and communities to encourage and support wetland restoration or enhancement efforts that do not increase aircraft-wildlife strike potentials.

Agree that the: U.S. Army Corps of Engineers (ACOE) has expertise in protecting and managing jurisdictional wetlands and their associated wildlife; U.S. Environmental Protection Agency (EPA) has expertise in protecting environmental resources; and the U.S. Fish and Wildlife Service (USFWS) has expertise in protecting and managing wildlife and their habitats, including migratory birds and wetlands. Appropriate signatory agencies will cooperatively review proposals to develop or expand wetland mitigation sites, or wildlife refuges that may attract hazardous wildlife. When planning these sites or refuges, the signatory agencies will diligently consider the siting criteria and land use practice recommendations stated in FAA AC 150/5200-33. The agencies will make every effort to undertake actions that are consistent with those criteria and recommendations, but recognize that exceptions to the siting criteria may be appropriate (see Paragraph F of this section).

Agree to consult with airport proponents during initial airport planning efforts. As appropriate, the FAA or USAF will initiate signatory agency participation in these efforts. When evaluating proposals to build new civilian or military aviation facilities or to expand existing ones, the FAA or the USAF, will work with appropriate signatory agencies to diligently evaluate alternatives that may avoid adverse effects on wetlands, other aquatic resources, and Federal wildlife refuges. If these or other habitats support hazardous wildlife, and there is no practicable alternative location for the proposed aviation project, the appropriate signatory agencies, consistent with applicable laws, regulations, and policies, will develop mutually acceptable measures, to protect aviation safety and mitigate any unavoidable wildlife impacts.

Agree that a variety of other land uses (e.g., storm water management facilities, wastewater treatment systems, landfills, golf courses, parks, agricultural or aquacultural facilities, and landscapes) attract hazardous wildlife and are, therefore, normally incompatible with airports. Accordingly, new, federally-funded airport construction or airport expansion projects near habitats or other land uses that may attract hazardous wildlife must conform to the siting criteria established in the FAA Advisory Circular (AC) 150/5200-33, Section 1-3.

Agree to encourage and advise owners and/or operators of non-airport facilities that are known hazardous wildlife attractants (See Paragraph J) to follow the siting criteria in Section 1-3 of AC 150/5200-33. As appropriate, each signatory agency will inform proponents of these or other land uses about the land use's potential to attract hazardous species to airport areas. The signatory agencies will urge facility owners and/or operators about the critical need to consider the land uses' effects on aviation safety.

Agree that FAA, USAF, and WS personnel have the expertise necessary to determine the aircraft-wildlife strike potentials of various land uses. When there is disagreement among signatory agencies about a particular land use and its potential to attract hazardous wildlife, the FAA, USAF, or WS will prepare a wildlife hazard assessment. Then, the appropriate signatory agencies will meet at the local level to review the assessment. At a minimum, that assessment will:

identify each species causing the aviation hazard, its seasonal and daily populations, and the population's local movements;

discuss locations and features on and near the airport or land use attractive to hazardous wildlife; and

evaluate the extent of the wildlife hazard to aviation.

Agree to cooperate with the airport operator to develop a specific, wildlife hazard management plan for a given location, when a potential wildlife hazard is identified. The plan will meet applicable FAA, USAF, and other relevant requirements. In developing the plan, the appropriate agencies will use their expertise and attempt to integrate their respective programmatic responsibilities, while complying with existing laws, regulations, and policies. The plan should avoid adverse impacts to wildlife populations, wetlands, or other sensitive habitats to the maximum extent practical. Unavoidable impacts resulting from implementing the plan will be fully compensated pursuant to all applicable Federal laws, regulations, and policies.

Agree that whenever a significant aircraft-wildlife strike occurs or a potential for one is identified, any signatory agency may initiate actions with other appropriate signatory agencies to evaluate the situation and develop mutually acceptable solutions to reduce the identified strike probability. The agencies will work cooperatively, preferably at the local level, to determine the causes of the strike and what can and should be done at the airport or in its vicinity to reduce potential strikes involving that species.

Agree that information and analyses relating to mitigation that could cause or contribute to aircraft-wildlife strikes should, whenever possible, be included in documents prepared to satisfy the National Environmental Policy Act (NEPA). This should be done in coordination with appropriate signatory agencies to inform the public and Federal decision makers about important ecological factors that may affect aviation. This concurrent review of environmental issues will promote the streamlining of the NEPA review process.

Agree to cooperatively develop mutually acceptable and consistent guidance, manuals, or procedures addressing the management of habitats attractive to hazardous wildlife, when those habitats are or will be within the siting criteria noted in Section 1-3 of FAA AC 5200-33. As appropriate, the signatory agencies will also consult each other when they propose revisions to any regulations or guidance relevant to the purpose of this MOA, and agree to modify this MOA accordingly.

SECTION II.

GENERAL RULES AND INFORMATION

Development of this MOA fulfills the National Transportation Safety Board's recommendation of November 19, 1999, to form an inter-departmental task force to address aircraft-wildlife strike issues.

This MOA does not nullify any obligations of the signatory agencies to enter into separate MOAs with the USFWS addressing the conservation of migratory birds, as outlined in Executive Order 13186, *Responsibilities of Federal Agencies to Protect Migratory Birds*, dated January 10, 2001 (66 *Federal Register*, No. 11, pg. 3853).

This MOA in no way restricts a signatory agency's participation in similar activities or arrangements with other public or private agencies, organizations, or individuals.

This MOA does not alter or modify compliance with any Federal law, regulation or guidance (e.g., Clean Water Act; Endangered Species Act; Migratory Bird Treaty Act; National Environmental Policy Act; North American Wetlands Conservation Act; Safe Drinking Water Act; or the "no-net loss" policy for wetland protection). The signatory agencies will employ this MOA in concert with the Federal guidance addressing wetland mitigation banking dated March 6, 1995 (60 *Federal Register*, No. 43, pg. 12286).

The statutory provisions and regulations mentioned above contain legally binding requirements. However, this MOA does not substitute for those provisions or regulations, nor is it a regulation itself. This MOA does not impose legally binding requirements on the signatory agencies or any other party, and may not apply to a particular situation in certain circumstances. The signatory agencies retain the discretion to adopt approaches on a case-by-case basis that differ from this MOA when they determine it is appropriate to do so. Such decisions will be based on the facts of a particular case and applicable legal requirements. Therefore, interested parties are free to raise questions and objections about the substance of this MOA and the appropriateness of its application to a particular situation.

This MOA is based on evolving information and may be revised periodically without public notice. The signatory agencies welcome public comments on this MOA at any time and will consider those comments in any future revision of this MOA.

This MOA is intended to improve the internal management of the Executive Branch to address conflicts between aviation safety and wildlife. This MOA does not create any right, benefit, or trust responsibility, either substantively or procedurally. No party, by law or equity, may enforce this MOA against the United States, its agencies, its officers, or any person.

This MOA does not obligate any signatory agency to allocate or spend appropriations or enter into any contract or other obligations.

This MOA does not reduce or affect the authority of Federal, State, or local agencies regarding land uses under their respective purviews. When requested, the signatory agencies will provide technical expertise to agencies making decisions regarding land uses within the siting criteria in Section 1-3 of FAA AC 150/5200-33 to minimize or prevent attracting hazardous wildlife to airport areas.

Any signatory agency may request changes to this MOA by submitting a written request to any other signatory agency and subsequently obtaining the written concurrence of all signatory agencies.

Any signatory agency may terminate its participation in this MOA within 60 days of providing written notice to the other agencies. This MOA will remain in effect until all signatory agencies terminate their participation in it.

SECTION III. PRINCIPAL SIGNATORY AGENCY CONTACTS

The following list identifies contact offices for each signatory agency.

Federal Aviation Administration Office Airport Safety and Standards Airport Safety and Compliance Branch (AAS-310) 800 Independence Ave., S.W. Washington, D.C. 20591 V: 202-267-1799 F: 202-267-7546	U.S. Air Force HQ AFSC/SEFW 9700 Ave., G. SE, Bldg. 24499 Kirtland AFB, NM 87117 V: 505-846-5679 F: 505-846-0684
U.S. Army Directorate of Civil Works Regulatory Branch (CECW-OR) 441 G St., N.W. Washington, D.C. 20314 V: 202-761-4750 F: 202-761-4150	U.S. Environmental Protection Agency. Office of Water Wetlands Division Ariel Rios Building, MC 4502F 1200 Pennsylvania Ave., SW Washington, D.C. 20460 V: 202-260-1799 F: 202-260-7546
U.S. Fish and Wildlife Service Division of Migratory Bird Management 4401 North Fairfax Drive, Room 634 Arlington, VA 22203 V: 703-358-1714 F: 703-358-2272	U.S. Department of Agriculture Animal and Plant Inspection Service Wildlife Services Operational Support Staff 4700 River Road, Unit 87 Riverdale, MD 20737 V: 301-734-7921 F: 301-734-5157

Signature Page

Associate Administrator for Airports Federal Aviation Administration	Date

Chief of Safety, U. S. Air Force	Date

Assistant Secretary of the Army (Civil Works), U.S. Army	Date

Assistant Administrator, Office of Water, U.S. Environmental Protection Agency	Date

Assistant Director, Migratory Birds and State Programs, U.S. Fish and Wildlife Service	Date

Deputy Administrator, Wildlife Services U.S. Department of Agriculture	Date

GLOSSARY

This glossary defines terms used in this MOA.

Airport. All USAF airfields or all public use airports in the FAA's National Plan of Integrated Airport Systems (NPIAS). Note: There are over 18,000 civil-use airports in the U.S., but only 3,344 of them are in the NPIAS and, therefore, under FAA's jurisdiction.

Aircraft-wildlife strike. An aircraft-wildlife strike is deemed to have occurred when:

1. a pilot reports that an aircraft struck 1 or more birds or other wildlife;
2. aircraft maintenance personnel identify aircraft damage as having been caused by an aircraft-wildlife strike;
3. personnel on the ground report seeing an aircraft strike 1 or more birds or other wildlife;
4. bird or other wildlife remains, whether in whole or in part, are found within 200 feet of a runway centerline, unless another reason for the animal's death is identified; or
5. the animal's presence on the airport had a significant, negative effect on a flight (i.e., aborted takeoff, aborted landing, high-speed emergency stop, aircraft left pavement area to avoid collision with animal)

(Source: *Wildlife Control Procedures Manual*, Technical Publication 11500E, 1994).

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

Bird Sizes. Title 40, Code of Federal Regulations, Part 33.76 classifies birds according to weight:

1. small birds weigh less than 3 ounces (oz).
2. medium birds weigh more than 3 oz and less than 2.5 lbs.
3. large birds weigh greater than 2.5 lbs.

Civil aircraft damage classifications. The following damage descriptions are based on the *Manual on the International Civil Aviation Organization Bird Strike Information System*:

1. Minor: The aircraft is deemed airworthy upon completing simple repairs or replacing minor parts and an extensive inspection is not necessary.
2. Substantial: Damage or structural failure adversely affects an aircraft's structural integrity, performance, or flight characteristics. The damage normally requires major repairs or the replacement of the entire affected component. Bent fairings or cowlings; small dents; skin punctures; damage to wing tips, antenna, tires or brakes, or engine blade damage not requiring blade replacement are specifically excluded.
3. Destroyed: The damage sustained makes it inadvisable to restore the aircraft to an airworthy condition.

Significant Aircraft-Wildlife Strikes. A significant aircraft-wildlife strike is deemed to have occurred when any of the following applies:

1. a civilian, U.S. air carrier aircraft experiences a multiple aircraft-bird strike or engine ingestion;
2. a civilian, U.S. air carrier aircraft experiences a damaging collision with wildlife other than birds; or
3. a USAF aircraft experiences a Class A, B, or C mishap as described below:
    a. Class A Mishap: Occurs when at least one of the following applies:
        i. total mishap cost is $1,000,000 or more;
        ii. a fatality or permanent total disability occurs; and/or
        iii. an Air Force aircraft is destroyed.
    b. Class B Mishap: Occurs when at least one of the following applies:
        i. total mishap cost is $200,000 or more and less than $1,000,000; and/or
        ii. a permanent partial disability occurs and/or 3 or more people are hospitalized;
    c. Class C Mishap: Occurs when at least one of the following applies:
        i. cost of reported damage is between $20,000 and $200,000;
        ii. an injury causes a lost workday (i.e., duration of absence is at least 8 hours beyond the day or shift during which mishap occurred); and/or
        iii. an occupational illness causing absence from work at any time.

Wetlands. An ecosystem requiring constant or recurrent, shallow inundation or saturation at or near the surface of the substrate. The minimum essential characteristics of a wetland are recurrent, sustained inundation or saturation at or near the surface and the presence of physical, chemical, and biological features indicating recurrent, sustained inundation, or saturation. Common diagnostic wetland features are hydric soils and hydrophytic vegetation. These features will be present, except where specific physiochemical, biotic, or anthropogenic factors have removed them or prevented their development. (Source the 1987 Delineation Manual; 40 CFR 230.3(t)).

Wildlife. Any wild animal, including without limitation any wild mammal, bird, reptile, fish, amphibian, mollusk, crustacean, arthropod, coelenterate, or other invertebrate, including any part, product, egg, or offspring there of (50 CFR 10.12, *Taking, Possession, Transportation, Sale, Purchase, Barter, Exportation, and Importation of Wildlife and Plants*). As used in this MOA, “wildlife” includes feral animals and domestic animals while out of their owner’s control (14 CFR 139.3, *Certification and Operations: Land Airports Serving CAB-Certificated Scheduled Air Carriers Operating Large Aircraft (Other Than Helicopters)*)

Table 1. Identified wildlife species, or groups, that were involved in two or more aircraft-wildlife strikes, that caused damage to one or more aircraft components, or that had an adverse effect on an aircraft's flight. Data are for 1990-1999 and involve only civilian, U.S. aircraft.

Birds	No. reported strikes
Gulls (all spp.)	874
Geese (primarily, Canada geese)	458
Hawks (primarily, Red-tailed hawks)	182
Ducks (primarily Mallards.)	166
Vultures (primarily, Turkey vulture)	142
Rock doves	122
Doves (primarily, mourning doves)	109
Blackbirds	81
European starlings	55
Sparrows	52
Egrets	41
Shore birds (primarily, Killdeer & Sandpipers)	40
Crows	31
Owls	24
Sandhill cranes	22
American kestrels	15
Great blue herons	15
Pelicans	14
Swallows	14
Eagles (Bald and Golden)	14
Ospreys	13
Ring-necked pheasants	11
Herons	11
Barn-owls	9
American robins	8
Meadowlarks	8
Buntings (snow)	7
Cormorants	6
Snow buntings	6
Brants	5
Terns (all spp.)	5
Great horned owls	5
Horned larks	4
Turkeys	4

Swans	3
Mockingbirds	3
Quails	3
Homing pigeons	3
Snowy owls	3
Anhingas	2
Ravens	2
Kites	2
Falcons	2
Peregrine falcons	2
Merlins	2
Grouse	2
Hungarian partridges	2
Spotted doves	2
Thrushes	2
Mynas	2
Finches	2
Total known birds	2,612

Mammals	No. reported strikes
Deer (primarily, White-tailed deer)	285
Coyotes	16
Dogs	10
Elk	6
Cattle	5
Bats	4
Horses	3
Pronghorn antelopes	3
Foxes	2
Raccoons	2
Rabbits	2
Moose	2
Total known mammals	340

Ring-billed gulls were the most commonly struck gulls. The U.S. ring-billed gull population increased steadily at about 6% annually from 1966-1988. Canada geese were involved in about 90% of the aircraft-goose strikes involving civilian, U.S. aircraft from 1990-1998. Resident (non-migratory) Canada goose populations increased annually at 13% from 1966-1998. Red-tailed hawks accounted for 90% of the identified aircraft-hawk strikes for the 10-year period. Red-tailed hawk populations increased annually at 3% from 1966 to 1998. Turkey vultures were involved in 93% of he identified aircraft-vulture strikes. The U.S. Turkey vulture populations increased at annually at 1% between 1966 and 1998. Deer, primarily white-tailed deer, have also adapted to urban and airport areas and their populations have increased dramatically. In the early 1900's, there were about 100,000 white-tailed deer in the U.S. Current estimates are that the U.S. population is about 24 million.

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APPENDIX I:
FAA Form 5200-7
Bird/Other Wildlife Strike Report

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Form Approved OMB NO. 2120-0045

U.S. Department of Transportation
Federal Aviation Administration

BIRD/OTHER WILDLIFE STRIKE REPORT

1. Name of Operator	**2. Aircraft Make/Model**	**3. Engine Make/Model**
4. Aircraft Registration	**5. Date of Incident** ____/____/____ Month Day Year	**6. Local Time of Incident** ☐ Dawn ☐ Dusk ☐ Day ☐ Night ___ HR ___ MIN ☐ AM ☐ PM
7. Airport Name	**8. Runway Used**	**9. Location if En Route** *(Nearest Town/Reference & State)*
10. Height *(AGL)*	**11. Speed** *(IAS)*	

12. Phase of Flight

- ☐ A. Parked
- ☐ B. Taxi
- ☐ C. Take-off Run
- ☐ D. Climb
- ☐ E. En Route
- ☐ F. Descent
- ☐ G. Approach
- ☐ H. Landing Roll

13. Part(s) of Aircraft Struck or Damaged

	Struck	Damaged		Struck	Damaged
A. Radome	☐	☐	H. Propeller	☐	☐
B. Windshield	☐	☐	I. Wing/Rotor	☐	☐
C. Nose	☐	☐	J. Fuselage	☐	☐
D. Engine No. 1	☐	☐	K. Landing Gear	☐	☐
E. Engine No. 2	☐	☐	L. Tail	☐	☐
F. Engine No. 3	☐	☐	M. Lights	☐	☐
G. Engine No. 4	☐	☐	N. Other:	☐	☐

(Specify, if "N. Other" is checked)

14. Effect on Flight

- ☐ None
- ☐ Aborted Take-Off
- ☐ Precautionary Landing
- ☐ Engines Shut Down
- ☐ Other: *(Specify)*

15. Sky Condition

- ☐ No Cloud
- ☐ Some Cloud
- ☐ Overcast

16. Precipitation

- ☐ Fog
- ☐ Rain
- ☐ Snow
- ☐ None

17. Bird/Other Wildlife Species

18. Number or birds seen and/or struck

Number of Birds	Seen	Struck
1	☐	☐
2-10	☐	☐
11-100	☐	☐
more than 100	☐	☐

19. Size of Bird(s)

- ☐ Small
- ☐ Medium
- ☐ Large

20. Pilot Warned of Birds ☐ Yes ☐ No

21. Remarks *(Describe damage, injuries and other pertinent information)*

DAMAGE / COST INFORMATION

22. Aircraft time out of service: ______ hours	**23. Estimated cost of repairs or replacement** *(U.S. $)*: $	**24. Estimated other cost** *(U.S. $) (e.g. loss of revenue, fuel, hotels)*: $

Reported by *(Optional)*	**Title**	**Date**

Paperwork Reduction Act Statement: The information collected on this form is necessary to allow the Federal Aviation Administration to assess the magnitude and severity of the wildlife-aircraft strike problem in the U.S. The information is used in determining the best management practices for reducing the hazard to aviation safety caused by wildlife-aircraft strikes. We estimate that it will take approximately 5 minutes to complete the form. If you wish to make any comments concerning the accuracy of this burden estimate and any suggestions for reducing this burden, send those comments to the Federal Aviation Administration, Management Staff, ARP-10, 800 Independence Avenue, SW, Washington, DC 20591. The information collected is voluntary. Please note that an agency may not conduct or sponsor, and a person is not required to respond to, a collection of information unless it displays a currently valid OMB control number. The OMB control number associated with this collection is 2120-0045.

FAA Form 5200-7 (3-97) Supersedes Previous Edition ☆ U.S. GPO: 1997-418-084/64203 NSN:0052-00-651-9005

U.S. Department
of Transportation

Federal Aviation Administration

800 Independence Ave., S.W.
Washington, D C 20591

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Penalty for Private Use, $300

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Federal Aviation Administration
Office of Airport Safety and Standards, AAS-310
800 Independence Avenue, SW
WASHINGTON, DC 20591

Directions for FAA Form 5200-7 Bird/Other Wildlife Strike Report

1. Name of Operator - This can be an airline (abbreviations okay - UAL, AAL, etc.), business (Coca Cola), government agency (Police Dept., FAA) or if a private pilot, his or her name.
2. Aircraft Make/Model - Abbreviations are okay, but try to include the model (e.g., B737-200).
3. Engine Make/Model - Abbreviations are allowed (e.g., PW 4060, GECT7, LYC 580).
4. Aircraft Registration - This means the N# (for USA registered aircraft).
5. Date of Incident - Give the local date, not the ZULU or GMT date.
6. Local Time of Incident - Check the appropriate light conditions and fill in the hour and minute local time and check AM or PM or use the 24 clock and skip AM/PM.
7. Airport Name - Use the airport name or 3 letter code if a US airport. If a foreign airport, use the full name or 3 letter code and location (city/country).
8. Runway used - Self explanatory.
9. Location if En Route - Put the name of the nearest city and state.
10. Height AGL - Put the feet above ground level at the time of the strike (if you don't know, use MSL and indicate this). For take-off run and landing roll, it must be 0.
11. Speed (IAS) - Speed at which the aircraft was traveling when the strike occurred.
12. Phase of Flight - Phase of flight during which the strike occurred. Take-off run and landing roll should both be 0 AGL.
13. Part(s) of Aircraft Struck or Damaged - Check which parts were struck and damaged. If a part was damaged but not struck, indicate this with a check on the damaged column only and indicate in comments (#21) why this happened (e.g., the landing gear might be damaged by deer strike, causing the aircraft to flip over and damage parts not struck by deer).
14. Effect on Flight - You can check more than one and if you check "Other", please explain in Comments (#21).
15. Sky Condition - Check the one that applies.
16. Precipitation - You may check more than one.
17. Bird/Other Wildlife Species - Try to be accurate. If you don't know, put unknown and some description. Collect feathers or remains for identification for damaging strikes.
18. Number of birds seen and/or struck - Check the box in the Seen column with the correct number if you saw the birds/other wildlife before the strike and check the box in the Struck column to show how many were hit. The exact number, can be written next to the box.
19. Size of Bird(s)- Check what you think is the correct size (e.g. sparrow = small, gulls = medium and geese = large).

Pilot Warned of Birds - Check the correct box (even if it was an ATIS warning or NOTAM).

20. Remarks - Be as specific as you can. Include information about the extent of the damage, injuries, anything you think would be helpful to know. (e.g., number of birds ingested).
21. Aircraft time out of service - Record how many hours the aircraft was out of service.
22. Estimated cost of repairs or replacement - This may not be known immediately, but the data can be sent at a later date or put down a contact name and number for this data.
23. Estimated other cost - Include loss of revenue, fuel, hotels, etc. (see directions for #23).

Reported by - Although this is optional, it is helpful if questions arise about the information on the form (a phone number could also be included).

Title - This can be Pilot, Tower, Airport Operations, Airline Operations, Flight Safety, etc.

Date - Date the form was filled out.

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APPENDIX J:
Gull Facts For Airport Wildlife Control Personnel

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Gull Facts for Airport Wildlife Control Personnel

Richard A. Dolbeer, USDA Wildlife Services

There are about 50 species of gulls in the world of which about 18 are regularly found in North America. North American gulls vary in size from 1/4 lb (little gull) to over 4 lbs (male great black-backed gull).

Gulls are the most frequently reported birds struck by civil aircraft in the USA. From 1990-2004, 25% of all identified bird strikes involved gulls.

The sexes are identical in plumage but males are generally slightly larger than females. For example, male laughing gulls weigh 10% more than females on average whereas male herring gulls weigh 19% more than females.

Gulls are generally long-lived with annual survival rates of 70 to >90%. A number of banded herring gulls have been recovered after 20 years and the record is over 30 years. Gulls begin losing bands due to wear and corrosion after 10 to 15 years so we really do not know how long they may live in the wild.

Male and female gulls form pairs during the nesting season and both sexes contribute about equally to nest building, incubation, and feeding of chicks. Clutch size is usually 3 eggs and incubation takes about 20 (laughing gull) to 28 days (great black-backed gull). Young fledge (begin flying) from 35 (laughing gull) to 50 days (great black-backed gull) after hatching. Gulls will renest if nests are destroyed early in the nesting season.

Gulls attain adult body size within 6 to 8 weeks of hatching but do not obtain adult plumage and mature sexually until 2 years (for small gulls) to 4-5 years (for large gulls). Plumage is generally all brown in the summer-fall of hatching year. Plumage acquires more adult characteristics with each successive molt. Plumage of immature gulls can be variable. Species identification and age classification of immature gulls can be difficult.

Gulls struck by aircraft should be identified to species when possible. Because of large variations in behavior, migration, and body size among gull species, correct species ID is critical for determining management actions at airports and for analysis of engine and airframe damage.

Convenient sources of information about gulls and other birds:

Dunning, J. B. Jr., editor. 1993. CRC Handbook of Avian Body Masses. CRC Press, Boca Raton, Florida. 371 pages. (Data on body weights for birds throughout the world)

Grant, P. J. 1986. Gulls: A Guide to Identification. Buteo Books, Vermilion, South Dakota. 352 pages. (Detailed plumage characteristics)

Ehrlich, P. R., D. S. Dobkin, and D. Wheye. 1988. The Birder's Handbook. Simon and Schuster, New York. 785 pages. (Provides a wealth of conveniently summarized life history information on most North American bird species)

Robbins, C. S., B. Bruun, and H. S. Zim. 1983. Birds of North America. Golden Press, New York. 360 pages. (Excellent field guide providing range maps for all bird species nesting in North America)

Sibley, D. A. 2000. The Sibley Guide to Birds. Alfred Knopf, New York. 544 pages. (Detailed plumage characteristics and good range maps).

FACTS FOR SELECTED GULL SPECIES IN NORTH AMERICA

Species	Mean body mass in lbs (grams)			Mean length in inches (cm)		Age (year) of first repro-duction
	Male	Both sexes	Female	Bill to tail	Wing-span	
Little Gull *Larus minutus*		0.25 (120)		11 (28)	24 (61)	2?
Bonaparte's Gull *Larus Philadelphia*		0.5 (212)		13 (33)	33 (81)	2-3
Franklin's Gull *Larus pipixcan*		0.6 (280)		14 (35)	36 (91)	2-3
Laughing Gull *Larus atricilla*	0.8 (345)		0.7 (312)	16 (41)	41 (104)	2-3
Mew Gull *Larus canus*	1.0 (432)		0.8 (375	16 (41)	43 (112)	3-4
Ring-billed Gull *Larus delawarensis*	1.2 (566)		1.0 (471)	17 (43)	49 (124)	3-4
California Gull Larus californicus	1.4 (657)		1.2 (556)	21 (53)	54 (137)	3-4
Herring Gull *Larus argentatus*	2.7 (1226)		2.3 (1044)	25 (63)	58 (147)	3-5
Glauc.-winged Gull *Larus glaucascens*	2.2 (1010)		2.2 (56)	26 (66)	58 (147)	3-5
Western Gull *Larus occidentalis*		2.2 (1011)		25 (63)	58 (147)	3-5
G. Black-backed gull *Larus marinus*	4.0 (1829)		3.3 (1488)	30 (76)	65 (165)	4-5

APPENDIX K:
Assessing Wildlife Hazard Management Plans At Civil Airports

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ASSESSING WILDLIFE HAZARD MANAGEMENT PLANS AT CIVIL AIRPORTS

This appendix describes a system (modified from Seubert 1994[1]) for objectively assessing the implementation of wildlife hazard management plans at civil airports. Five assessment categories, each with a list of elements to be evaluated, are used to indicate how well airport wildlife hazard management plans are being implemented.

Category 1. Management functions related to wildlife hazards on or in the vicinity of the airport.

Category 2. Bird control on or in the vicinity of the airport.

Category 3. Mammal control on or in the vicinity of the airport.

Category 4. Management of habitat and food sources on airport property related to wildlife hazards.

Category 5. Land uses and food sources off of airport potentially related to wildlife hazards on airport.

The elements described in Categories 1-4 are assessed as to the degree that management programs are being implemented. The elements in Category 5 are rated as to the degree of hazard posed. Elements within each category are not intended to cover every possibility – they can be modified or expanded to meet situations unique to an airport.

During an assessment, each element in Categories 1-4 is examined and classified as one of the following:

S = Satisfactory. If an assessor finds that an airport has initiated action to reduce a wildlife hazard according to plan and is on schedule, the action would be considered “satisfactory”.

U = Unsatisfactory. If no measures have been taken or inappropriate measures taken, the assessment would be “unsatisfactory”.

NI = Needs improvement. If implementation of a control measure is behind schedule or only partially accomplished, the assessment would be either “needs improvement”, or “unsatisfactory”, depending on the seriousness of the hazard.

NA = Not applicable. If it is apparent that certain listed techniques or items are not applicable to the airport, the assessment would be “not applicable”.

If an assessment is either “NI” or “U”, a comment by an assessor is required on the Assessment Summary Form (last page). Examples of assessments requiring comments are as follows:

---

[1] Seubert, J. L. 1994. Assessing the implementation of wildlife hazard management programs at civil airports. Proceedings Bird Strike Committee Europe 22:275-284.

Category 1. Management functions related to wildlife hazards on or in the vicinity of the airport.

If permits have not been obtained (Code 1.1) for shooting or trapping birds or mammals, the assessment would be “U”.

If animal remains found on runways are being counted to document bird strikes, but are not being identified by species (Code 1.13), the assessment would be “NI”.

Category 2. Bird control on or in the vicinity of airports.

If bioacoustics are not being used (Code 2.2), the assessment would be “U”.

If the installation of wires (Code 2.9) over an airport pond is behind schedule, the assessment could be “NI” or “U”, depending on the degree of potential hazard.

If raptors are not being trapped and relocated (Code 2.22), the assessment would be “U”.

Category 3. Mammal control on or in the vicinity of airports.

If fencing (Code 3.2) is in need of repair, the assessment would be “NI”.

If rodenticides (Code 3.12) are not being used to control a rodent population attracting raptors, the assessment would be “U”.

Category 4. Management of habitat and food sources on airport property related to wildlife hazards.

If airport litter control is inadequate (Code 4.9), the assessment would be “NI”.

If trees used as a roost site (Code 4.3) are not being eliminated or thinned to be made unattractive, the assessment would be “U”.

Categories 1-4 focus on actions that can be taken on the airport to reduce wildlife hazards.

Category 5. Land uses and food sources off of airport potentially related to wildlife hazards on airport.

This provides a list of off-airport land uses and food sources that may be attractive to birds or other wildlife. The assessor should review this list and score each element on a scale of 0 to 3:

0 = land use or food source not present;

1 = present but no wildlife problems noted or anticipated;

2 = site attracts some hazardous wildlife creating possible or potential problem, site should be monitored;

3 = site creates significant wildlife hazard for airport, action should be taken.

Wildlife hazards at airports frequently are attributable to these off-site attractants, but airport managers have no authority over the use of private property. However, airport managers can initiate programs to reduce the hazards of these off-airport wildlife attractants (e.g., garbage dumps, certain agricultural activities) by informing local jurisdictions and landowners of the hazards, and suggesting ways of alleviating them (Code 1.12).

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Airport	Date	Assessment Page 1 of 6
CATEGORY 1. Management functions related to wildlife hazards on or in the vicinity of the airport.		

CODE	ITEMS	ASSESSMENT			
		S	NI	U	NA
1.1	Acquiring wildlife control permits from federal, state, and local agencies				
1.2	Arranging for wildlife hazard assessments and other studies, as needed, to evaluate hazard potential of wildlife attracted by habitats, land uses, and food sources on or in vicinity of airport.				
1.3	Developing Wildlife Hazard Management Plan based on Wildlife Hazard Assessment and other studies and factors.				
1.4	Defining and delegating authority and responsibility for Wildlife Hazard Management Plan.				
1.5	Supervising, implementing, and coordinating airport Wildlife Hazard Management Plan.				
1.6	Evaluating Wildlife Hazard Management Plan at least once/yr.				
1.7	Training personnel responsible for implementing airport Wildlife Hazard Management Plan, especially field personnel.				
1.8	Operating wildlife patrol system with a trained field staff , conducting surveillance/inspections of critical airport areas, and effecting wildlife control when needed or requested.				
1.9	Establishing a communication capability between wildlife control and ATC personnel.				
1.10	Maintaining a system for warning pilots about wildlife hazards (e.g., NOTAMS, ATC, Radar observations).				
1.11	Ensuring that airport habitats are managed to reduce or eliminate wildlife attractions.				
1.12	Ensuring that airport policy prohibits feeding of wildlife and exposure of food wastes.				
1.13	Interacting with local jurisdictions and landowners about zoning, land use, and the resolution of wildlife hazard problems in vicinity of airport.				
1.14	Maintaining log book with daily record of wildlife control activities, wildlife activity, and reported wildlife strikes and wildlife remains found on runways identified by species.				
1.15	Reporting all wildlife strikes to FAA.				

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Airport	Date	Assessment Page 2 of 6
CATEGORY 2. Bird control on or in the vicinity of the airport.		

CODE	TECHNIQUES	ASSESSMENT			
		S	NI	U	NA
DISPERSE, DETER, EXCLUDE, REPEL					
2.1	Bird patrols in vehicle				
2.2	Bioacoustics (distress calls)				
2.3	Electronically generated noise				
2.4	Propane cannons				
2.5	Pyrotechnics				
2.6	Shooting to scare				
2.7	Netting hanger rafters, ponds etc.				
2.8	Perching deterrents (e.g., stainless steel needles)				
2.9	Overhead wires for ponds, ditches, roofs etc.				
2.10	Chemical repellents				
2.11	Falconry				
2.12	Dogs				
2.13	Radio-controlled aircraft				
2.14	Thinning or eliminating roosting trees and shrubs				
2.15	Grass management				
2.16	Scarecrows				
2.17	Dead bird effigies				
REMOVE					
2.18	Chemical capture (alpha chloralose)				
2.19	Nest and egg destruction				
2.20	Poisoning				
2.21	Predators to remove eggs (foxes, pigs, etc.)				
2.22	Shooting				
2.23	Trapping and relocation (e.g., raptors)				

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Airport	Date	Assessment Page 3 of 6
CATEGORY 3. Mammal control on or in the vicinity of the airport.		

		ASSESSMENT			
CODE	TECHNIQUES	S	NI	U	NA
DISPERSE, DETER, EXCLUDE, REPEL					
3.1	Cattle guards				
3.2	Fencing				
3.3	Vehicle patrols				
3.4	Propane cannons				
3.5	Pyrotechnics				
3.6	Rodent-resistant sheathing on electrical cables				
REMOVE					
3.7	Controlled hunting (e.g., deer)				
3.8	Den destruction (e.g., coyotes)				
3.9	Fumigants (e.g., woodchucks)				
3.10	Kill trapping (e.g., beavers, muskrats)				
3.11	Live trapping and relocation or euthanasia (e.g., dogs)				
3.12	Rodenticides (e.g., mice, ground squirrels)				
3.13	Shooting (e.g., deer, woodchucks, hares)				

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Airport	Date	Assessment Page 4 of 6
CATEGORY 4. Management of habitat and food sources on airport property related to wildlife hazards.		

CODE	ITEMS	ASSESSMENT			
		S	NI	U	NA
AGRICULTURE/VEGETATION MANAGEMENT					
4.1	Agricultural crops (especially cereal grains and sunflowers)				
4.2	Plowing, mowing, harvesting (rodents, insects, worms)				
4.3	Landscaping (fruits & roost sites attractive to birds)				
4.4	Brush, shrubs, wood lots (cover, browse for deer)				
4.5	Misc. nesting sites (e.g., trees) for egrets, raptors, etc.				
WASTE MANAGEMENT/SANITATION					
4.6	Feeding birds and mammals (by people)				
4.7	Food waste storage (e.g., cafeterias, catering services)				
4.8	Garbage dumps				
4.9	Litter				
4.10	Sewage treatment ponds/lagoons/outfalls				
4.11	Weeds, construction debris, junk yards				
4.12	Animal carcasses (dead livestock, bird strike remains)				
WATER SOURCES					
4.13	Aquatic vegetation				
4.14	Canals, ditches, creeks, waterways				
4.15	Low areas on pavement/ground that collect water				
4.16	Retention ponds (water, de-icing fluid)				
4.17	Water fountains				
MISCELLANEOUS ATTRACTANTS					
4.18	Earthworms along runways				
4.19	Insects hatches from vegetation or soil				
4.20	Seed-producing vegetation.				
4.21	Flat roofs (e.g., gull nesting and loafing sites)				
4.22	Structures (hangers, towers, signs, poles, etc.)				

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Airport	Date	Assessment Page 5 of 6
CATEGORY 5. Land uses and food sources off airport potentially related to wildlife hazards on airport.		

CODE	ITEMS	Score[a]	COMMENTS
	AGRICULTURE		
5.1	Agricultural crops (especially cereal grains)		
5.2	Aquaculture facilities		
5.3	Livestock feedlots		
5.4	Grain storage or grain mills		
	COMMERCIAL/RECREATIONAL LAND USES		
5.5	Drive-in theaters, amusement parks etc.		
5.6	Restaurants (esp. outdoor eating areas)		
5.7	Picnic areas, parks		
5.8	Marinas		
5.9	Golf courses		
5.10	Flat roofs (gull nesting sites)		
	WASTE MANAGEMENT		
5.11	Garbage barges		
5.12	Garbage dumps		
5.13	Garbage transfer stations		
5.14	Fish processing plants		
5.15	Sewage lagoons, outfalls		
	WATER SOURCES		
5.16	Retention ponds (water, feedlots, etc.)		
5.17	Canals, creeks, ditches		
5.18	Reservoirs, lakes, natural ponds		
	NESTING/LOAFING/FEEDING AREAS		
5.19	Wildlife refuges/nature preserves		
5.20	Misc. nesting sites (egrets, raptors, etc.)		
5.21	Roosting trees (starlings, egrets, etc.)		
5.22	Marshes, swamps, mud flats		

[a] 0 = not present;
1 = present but no wildlife problems noted or anticipated;
2 = site attracts some hazardous wildlife creating possible or potential problem, site should be monitored;
3 = site creates significant wildlife hazard for airport, action should be taken.

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Airport	Date	Assessment Page 6 of 6
SUMMARY FORM (Wildlife Hazard Assessment): Comments are required for all elements in Categories 1-4 assessed as “Unsatisfactory” or as “Needs Improvement” or with a score of 2 or 3 in Category 5.		

Manager or wildlife supervisor:	Phone:
	Fax:
	E mail:
Assessor:	Phone:
	Fax:
	E mail:

Assessor’s comments for elements rated “unsatisfactory” or “needs improvement” in Categories 1-4 or for elements scored 2 or 3 in Category 5.

Element code	Assessment symbol	Comments

Assessor’s general comments (use back if needed):

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APPENDIX L:
Aviary And Field Evaluations Of Various Wildlife Control Products And Strategies For Airports

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AVIARY AND FIELD EVALUATIONS OF VARIOUS WILDLIFE CONTROL PRODUCTS AND STRATEGIES FOR AIRPORTS

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Numerous products and strategies are available to reduce bird and other wildlife activity around airport buildings and runways. Many of these products and strategies are promoted and sold with only anecdotal evidence to support efficacy claims. Wildlife damage biologists frequently are asked for advice on the purported efficacy of these approaches. Too often, no data or insufficient data are available to make informed recommendations about a particular product. Thus, purchases are often made and products or strategies deployed that prove unsatisfactory. Not only do these purchases result in wasted money, but they may also increase hazards if airport personnel believe the deployment of an ineffective strategy has solved the problem.

Evaluation of these devices and strategies under controlled conditions with sufficient replications to provide statistically rigorous results is difficult, especially for birds. The Ohio Field Station (OFS) of the U.S. Department of Agriculture's National Wildlife Research Center (NWRC) is located on a 5,400-acre fenced site, Plum Brook Station [PBS], operated by the National Aeronautical and Space Administration, Erie County, Ohio. PBS provides an ideal outdoor laboratory for wildlife damage control tests. The site contains an outdoor aviary and a 10-acre Canada goose pond and grass facility for tests with captive birds. PBS also has large populations of free-roaming deer, starlings and other wildlife. PBS is within 50 miles of several large gull colonies along the shore of Lake Erie where testing also can be done.

Through an interagency agreement with the Federal Aviation Administration (FAA) and cooperative agreements with the Port Authority of New York and New Jersey (PANYNJ) and private companies, the OFS has evaluated over 35 wildlife control products and strategies from 1992-2004. These tests provide objective data on the efficacy and limitations of various products and strategies—information that should be helpful to airport personnel and wildlife damage control biologists. Having said this, I emphasize that these tests typically do not provide a definitive, all-encompassing assessment of a product's value or limitations. Product efficacy may vary depending on species, time of year, context of presentation and other factors. However, the tests do provide objective data on performance under controlled or measured conditions so that at least some conclusions can be drawn regarding potential usefulness in an airport environment.

Below is a listing of publications with abstracts by species group that document the results of many of these tests. Copies of the full publications can be obtained from university libraries or by contacting the NWRC library at www.aphis.usda.gov/ws/nwrc. I acknowledge the creative test designs developed and work carried out by the various USDA employees listed in the publications. I also acknowledge the support provided by the FAA, especially S. Agrawal, M. Hovan, and T. Hupf (William J. Hughes Technical Center, Atlantic City, NJ) and E. C. Cleary (Office of Airport Safety and Standards, Washington, DC) and the PANYNJ (L. Francoeur).

GULLS AND RELATED SPECIES

1. Belant, J. L. 1997. Gulls in urban environments: landscape-level management to reduce conflict. Landscape and Urban Planning 38:245-258. *Abstract:* Populations of several species of gulls (*Larus* spp.) have increased dramatically throughout coastal areas of North America and Europe during the past several decades. These increases have been attributed to protection from human disturbance, reduction in environmental contaminants, availability of anthropogenic food, and the ability of gulls to adapt to human-altered environments. Gull abundance in urban areas has resulted in numerous conflicts with people including hazards to aircraft, damage to buildings from nesting material and defecation, and general nuisance. Various architectural and habitat management approaches are available to reduce gull/human conflicts. For example, gull use of landfills may be reduced by covering refuse, diverting anthropogenic food to covered compost facilities, erecting wire grids over exposed refuse, and manipulation of turf height in loafing areas. Nesting on roofs can be alleviated through modifications of roofing substrate and placement of overhead wires. Also, attractiveness of airports to gulls can be reduced through drainage of temporary water and by decreasing the availability of prey and loafing sites through habitat management. Although control activities can be effective at the site where the gull problem occurs, uncoordinated management efforts may cause relocation of problems to surrounding areas. Also, site-specific management will rarely solve the problem across a larger scale (e.g., city-wide). A working group comprised of the respective city or county planning commission, affected businesses, private citizens, and wildlife professionals can provide overall direction for gull management. This working group should define the extent and nature of the problem, develop an appropriate management strategy incorporating ecology of the nuisance species, and conduct periodic assessments of program efficacy. An integrated, landscape-level management approach is necessary to ensure an overall reduction in conflict between gulls and people in urban environments.

2. Belant, J. L., S. W. Gabrey, R. A. Dolbeer, and T. W. Seamans. 1995. Methyl anthranilate formulations repel gulls and mallards from water. Crop Protection 14:171-175. *Abstract:* Two formulations of methyl anthranilate (MA), one (ReJeX-iT™ TP-40 [TP-40]) containing a surfactant, the other (ReJeX-iT™ AP-50 [AP-50]) a miscible, free-flowing powder, effectively repelled captive mallards from pools of water in a pen test and/or free-ranging ring-billed and herring gulls from pools of water at a landfill for 4 to 11 days. With one exception, pool entries and bill contacts with water were reduced ($P \leq 0.02$) in pools treated with either formulation compared to untreated pools. Overall gull activity was reduced ($P \leq 0.01$) when all available water was treated with AP-50. Repellency of gulls and mallards from water was achieved with concentrations of MA (0.016-0.038%, v/v) 10-60 times lower than needed in previous studies to repel birds from food. These tests indicate that MA-based formulations in low concentrations should have utility in various agricultural and other situations where it is desirable to reduce bird activity in water.

3. Belant, J. L., and S. K. Ickes. 1996. Overhead wires reduce roof-nesting by ring-billed and herring gulls. Proceedings of the Vertebrate Pest Conference 17:108-112. *Abstract:* We evaluated the effectiveness of overhead wires in reducing roof-nesting by ring-billed gulls (*Larus delawarensis*) and herring gulls (*L. argentatus*) at a 7.2-ha food warehouse in northern Ohio during 1994-1995. In 1994, stainless steel wires (0.8 mm diameter) were attached generally in spoke-like configurations between 2.4 m upright metal poles spaced at 33.7-m intervals over the main portion of roof. The 6-14 wires radiating from each pole created a mean maximum spacing between wires of about 16 m. Nesting by ring-billed and herring gulls was reduced by 76% and 100% in 1994 and by 99% and 100% in 1995, respectively, compared to 1993 pretreatment levels (1,011 ring-billed gull nests and 98 herring gull nests). Ring-billed gulls that constructed nests after wire installation gained access to the roof where wires were not installed along the roof edge, where wires were broken, by hovering over wires and landing between them, or from structures such as air conditioners that were at or above the level of surrounding wires. Initial placement of overhead wires above roof structures and regular maintenance of broken wires is recommended to increase effectiveness. Mean maximum spacing of 16 m between wires was effective in excluding nesting by herring gulls; however, narrower spacing is necessary to exclude nesting by ring-billed gulls. Also, many of the ring-billed gulls displaced by wires from the warehouse in 1994 relocated to nest on an adjacent building without overhead wires. Thus, although overhead wires can be effective in reducing nesting by gulls on roofs and in other urban situations, management should be considered at a scale broader than specific problem sites as displacement of nesting gulls may cause relocation of the colonies to surrounding areas.

4. Belant, J. L., and S. K. Ickes. 1997. Mylar flags as gull deterrents. Proceedings of the Great Plains Wildlife Damage Control Conference 13:73-80. *Abstract:* During 1996, we evaluated the effectiveness of mylar flags for deterring herring gulls (*Larus argentatus*) from 2 nesting colonies (roof and breakwall) and herring and ring-billed (*L. delawarensis*) gulls from 2 loafing sites at a landfill. Mylar flags (15 cm x 1.0 m) attached to wire or lathe supports were positioned at 6-m intervals at nesting colonies and 3- to 12-m intervals at loafing areas. For both nesting colonies, time of nest initiation, nest density, and clutch size in 1996 when flags were present was similar to or greater than values obtained for these parameters at the same colonies in 1995 when flags were not present. The maximum number of chicks observed at the roof colony in 1996 was also similar to the maximum number of chicks observed in 1995. At the landfill, we observed fewer gulls ($P < 0.05$) at 1 loafing site during the 2 weeks when mylar flags (6- and 12-m spacing) were present than during the 2 weeks when flags were not present. In contrast, gull use of the second loafing area did not appear influenced by the presence of mylar flags (3- and 6-m spacing), likely because of its small size (6 x 90 m) and proximity to a frequently used pond. We conclude that mylar flags are ineffective in deterring herring gulls (and likely other gulls) from nesting colonies but can reduce gull use of loafing areas.

5. Blackwell, B. F., T. W. Seamans, D. A. Helon, and R. A. Dolbeer. 2000. Early loss of herring gull clutches after egg-oiling. Wildlife Society Bulletin 28(1):70-75.
Abstract: Critical to the success of egg-oiling as a means to control growth of bird populations is extension of the incubation period, thereby minimizing renesting attempts. Egg-oiling studies conducted with ring-billed (*Larus delawarensis*) and herring (*L. argentatus*) gulls generally have reported no evidence of abandonment of oiled clutches up to the expected hatching date (EHD). However, comparisons of clutch loss (assumed primarily to predation) up to EHD among control and treatment groups were not reported. Therefore, we evaluated early (oiling 21-27 days before EHD) and late (oiling 7-15 days before EHD) oiling protocols in a herring gull colony on Lake Erie, Erie County, Ohio. Marked differences ($P < 0.01$) were observed among treatments in the number of nests producing chicks (90.0%, n = 100, control; 20%, n = 100, early oil, and 1%, n = 100, late oil). Clutches in nests assigned to the 2 oil groups were more frequently ($P < 0.01$) lost (6% control; 29% early; 38% late) to abandonment, storms, and predation up to EHD. Only 56% of oiled clutches were incubated past EHD. Clutch loss (including nest abandonment) up to EHD did not differ ($P = 0.35$) between nests in the early and late oil groups. Our data suggest that herring gulls were sensitive to oil and that nests were abandoned or clutches lost within the normal incubation period in numbers greater than expected under natural conditions. The effectiveness of egg-oiling in reducing recruitment in herring gull colonies is improved by oiling nests late in the incubation period. Subsequent oil applications will allow for inclusion of late nests and renesting attempts.

6. Dolbeer, R. A. 1998. Keynote Address: Population dynamics: the foundation of wildlife damage management for the 21st century. Proceedings of the Vertebrate Pest Conference 18:2-11. *Abstract:* To justify and defend lethal or reproductive control programs to solve vertebrate pest problems, wildlife biologists must have a sound understanding of the population status and dynamics of the problem species. Models are essential to project how populations will respond to proposed management actions, providing a scientific foundation to counter the emotional debates that often arise. Four population models (PM1-PM4) for predicting population responses are described. PM1 and PM2 explore the relative efficacy of reproductive and lethal control for vertebrate species over 10-year intervals. PM3 simulates population responses to actual management actions through 10-year intervals. PM4 simulates population changes for a species at weekly intervals over an annual cycle, exploring the immediate ($\leq$1 year) impact of population management actions. Population simulations using PM1 and PM2 demonstrated that for most vertebrate pest species considered, lethal control will be more efficient than reproductive control in reducing population levels. Reproductive control is more efficient than lethal control only for some rodent and small bird species with high reproductive rates and low survival rates. A simulation (PM3) of the removal of 47,000 laughing gulls (*Larus atricilla*) from the Long Island-New Jersey population accurately predicted the 33% decline of the population over 5 years. A simulation (PM4) of the annual cycle of the common grackle (*Quiscalus quiscula*) population in the eastern United States demonstrated why removing 4.2 million birds in 1 winter had no discernible impact on subsequent breeding populations. Understanding the population dynamics of wildlife

species is the cornerstone to successful management, and population models will be essential for this task in the years to come.

7. Dolbeer, R. A., D. P. Arrington, E. LeBoeuf, and C. Atkins. 1996. Can albatrosses and aircraft coexist on Midway Atoll? Bird Strike Committee Europe 23:327-335. *Abstract:* Aircraft collisions with birds (bird strikes), especially Laysan albatrosses (*Diomedea immutabilis*), have been a problem at Midway Naval Air Facility since at least the 1950s. Although aircraft movements at Midway presently are reduced relative to 1950-1970 levels, the U.S. Navy in 1993 still reported 57 strikes during 459 aircraft movements. We visited Midway from 15-21 April 1995 to determine the species composition and diurnal pattern of bird flights over Runway 6-24 so that recommendations could be made regarding timing of aircraft movements to minimize strikes. Midway Atoll in 1994-1995 had an estimated 450,000 nesting pairs of albatrosses (900,000 adults), a mean density of 725 nests/ha. We recorded a mean of 363 birds (89% Laysan albatrosses) crossing the runway/minute during daylight hours. At night (2230-2300), we estimated only 5.7 birds/minute (89% Bonin petrels [*Pterodroma hypoleuca*]) flying over the runway, a 98.5% reduction over mean numbers during daylight. As Midway Atoll goes through the transition from military base to wildlife refuge, nonemergency aircraft movements should be restricted to night from November-mid July. Furthermore, any plans to develop "ecotourism" or other activities for the Atoll will need to factor in this constraint for aircraft movements. Under present conditions, daytime aircraft movements for commercial or private carriers would raise serious safety and liability issues.

8. Dolbeer, R. A., J. L. Belant, and J. Sillings. 1993. Shooting gulls reduces strikes with aircraft at John F. Kennedy International Airport. Wildlife Society Bulletin 21:442-450. *Abstract:* The collision of birds with aircraft is a serious problem at John F. Kennedy International Airport (JFKIA), New York City. Laughing gulls comprised 47% of the birds colliding with aircraft from 1988 to 1990, averaging 170 bird strikes per year. This species is present from May to September in association with a 7,600-nest colony (1990) adjacent to the airport. Other gulls (herring, great black-backed, and ring-billed), which are present year-round, comprised 37% of the strikes and another 52 species of birds comprised the remaining 16%. The airport has an active bird management program involving habitat alteration and the use of bird-frightening techniques to discourage birds from feeding, drinking, and loafing on airport grounds. However, these measures do little to prevent laughing gulls and other gull species from flying over the airport to non-airport feeding sites. An experimental program to reduce gull collisions with aircraft was undertaken in 1991 and 1992 in which 2 to 5 people stationed on airport boundaries used shotguns to shoot gulls flying over the airport from mid-May to early August. There were high levels of gull activity at JFKIA in the summers of 1991 and 1992, as evidenced by the ability of shooters to kill 26,038 laughing gulls and 2,314 other gulls flying over the airport in 2,206 person-hours of shooting. Shooting did not appear to condition gulls to avoid flying over the airport. The shooting program at JFKIA substantially reduced the incidences of strikes between all species of gulls and aircraft, by 70% in 1991 and 89% in 1992. The laughing gull nesting colony in its present location presents an unacceptable safety hazard to aircraft. The annual killing of large numbers of laughing gulls on the airport, while effective in reducing strikes, may not be effective in eliminating the colony from its present location.

Discussions should continue with NPS personnel to develop a plan to relocate the colony from Jamaica Bay. This plan could include habitat alteration, nest destruction, and other harassment and management techniques at the colony. However, a seasonal shooting program should continue on the airport to minimize the number of gull-aircraft collisions until the laughing gull colony is relocated from Jamaica Bay.

9. Dolbeer, R. A., R. B. Chipman, A. L. Gosser, and S. C. Barras. 2003. Does shooting alter flight patterns of gulls: case study at John F. Kennedy International Airport. Proceedings of 26th International Bird Strike Committee meeting. WP-BB5 *Abstract.* The collision of birds with aircraft (bird strikes) is a serious problem at John F. Kennedy International Airport (JFK), New York. Gulls (Larus spp.), of which 60% were laughing gulls (L. atricilla), accounted for 86% of bird strikes from 1988-1990, averaging 261 strikes per year. Laughing gulls are present from May-September in association with a nesting colony in Jamaica Bay adjacent to the airport. A program to reduce gull strikes was conducted from May-August 1991-2002 in which 2-5 people stationed on airport boundaries shot gulls flying over the airport. As a result of the shooting program, the number of strikes with laughing gulls was reduced to 38% of 1988-1990 levels in 1991 and to 1-24% of 1988-1990 levels in 1992-2002. Strikes by the 3 other gull species were reduced to 24-52% of preshooting levels over the same time period. The laughing gull colony in Jamaica Bay has declined 58% from 7,629 nests in 1990 to 3,238 nests in 2002. That the colony size declined by only 58% from 1990-2002 while the annual strike rate of laughing gulls declined by 97% (1990-2002) indicated that many laughing gulls altered flight patterns in response to shooting to avoid the airport. Although the shooting program has reduced the local population of gulls flying over JFK, the regional population has not been negatively impacted. Our recommended long-term solution to minimize gull-aircraft collisions and the number of gulls shot is to relocate the nesting colony away from JFK. This study demonstrated that shooting can significantly reduce gull-aircraft collisions at an airport by both reducing the local population and altering flight patterns of surviving gulls. A seasonal gull-shooting program should continue at JFK as part of the integrated management program to reduce bird hazards to aviation.

10. Ickes, S. I., J. L. Belant, and R. A. Dolbeer. 1998. Nest disturbance techniques to control nesting by gulls. Wildlife Society Bulletin 26:269-273. *Abstract:* Urban-nesting gulls throughout the lower Great Lakes often conflict with human activities. We evaluated 5 nest disturbance techniques (nest-and-egg removal, egg removal, nest-and-egg destruction, egg destruction, and egg replacement) to reduce herring gull (*Larus argentatus*) and ring-billed gull (*L. delawarensis*) nesting in urban habitat, primarily roofs, in northern Ohio. Nest disturbance techniques were more effective in causing colony abandonment for ring-billed gulls than for herring gulls. Nest disturbance conducted for 1 year at an established ring-billed gull colony, and for <1 week at a newly established ring-billed gull colony caused abandonment. Nest disturbance conducted for 1 to 10 years did not cause herring gulls to abandon 5 of 6 established colonies; however, reductions were observed in annual maximum number of nests or eggs. Egg removal was at least as effective as nest-and-egg removal and required about 60% less effort. Egg replacement was the least effective of the techniques evaluated. Unless structural damage to buildings is of concern, egg removal is recommended over other nest disturbance techniques evaluated for inexpensive, long-term reductions of roof-nesting colonies. Nest-and-egg or egg destruction is recommended for ground-nesting colonies. Use of other control methods (e.g., habitat modification, frightening techniques) in addition to nest disturbance may increase the potential for colony abandonment.

11. Seamans, T. W., and J. L. Belant. 1999. Comparison of DRC-1339 and alpha-chloralose for reducing herring gull populations. Wildlife Society Bulletin 27(3):729-733. *Abstract*: Results of several herring gull (*Larus argentatus*) control programs using DRC-1339 (3-chloro-4-methyl-benzenamine hydrochloride) suggested that the published median lethal dose (LD_{50}) of 2.9 mg of DRC-1339/kg of body weight may not be accurate in some environments. We conducted laboratory trials to estimate LD_{50} values of DRC-1339 and of alpha-chloralose (AC) for herring gulls inhabiting fresh water. We also conducted field trials to compare effectiveness of these compounds in simulated gull control operations. We calculated the LD_{50} for DRC-1339 as 4.6 mg/kg and 43.1 mg/kg for AC. Mean (± SD) time to death for DRC-1339-dosed birds varied from 34.0 (± 12.2) hours at LD_{96} to 109.5 (± 55.5) hours at LD_{27}. AC time to death varied from 2.3 (± 0.5) hours at $>LD_{99}$ to 5.8 (± 0.0) hours at LD_{13}. In field trials, DRC-1339 baits treated at 27.4 mg/kg (LD_{99}) resulted in 29% known mortality. In contrast, AC baits with a 30 mg/kg dosage ($<LD_{01}$) resulted in 50% capture success and no mortality. AC baits at 58 mg/kg (LD_{99}) resulted in 89% capture success and 41% mortality. With AC baits at 95 mg/kg ($> LD_{99}$), 65% of gulls were captured with 82% mortality. AC was more effective than DRC–1339 in removing gulls from a nesting colony. We recommend AC as a gull population management chemical because it is fast acting, humane, and can be used as a nonlethal capture agent.

BLACKBIRDS AND STARLINGS

12. Belant, J. L., S. K. Ickes, L. A. Tyson, and T. W. Seamans. 1997. Comparison of d-pulegone and mangone as cowbird feeding repellents. International Journal of Pest Management 43:303-305. *Abstract:* We compared the effectiveness of d-pulegone and mangone as feeding repellents to captive adult male brown-headed cowbirds (*Molothrus ater*) during October-November 1995. For each repellent, we conducted 4-day, 1- and 2-choice cage tests using concentrations (g/g) of 0.1%, 0.01%, and 0.001% with millet. During 1- and 2-choice tests, 0.1% d-pulegone reduced ($P <$ 0.01) cowbird feeding but lower concentrations did not. In contrast, concentrations of mangone as low as 0.001% reduced ($P < 0.05$) food consumption during 2-choice tests. Consumption of mangone-treated millet, however, was similar ($P > 0.05$) among 1-choice tests and similar to total food consumption observed during 2-choice tests. We conclude that mangone is less effective than d-pulegone and would likely be ineffective as a repellent for seed treatment. We recommend field tests to further assess the effectiveness of d-pulegone as an avian feeding repellent.

13. Belant, J. L., P. P. Woronecki, R. A. Dolbeer, and T. W. Seamans. 1998. Ineffectiveness of five commercial deterrents for nesting starlings. Wildlife Society Bulletin 26:264-268. *Abstract:* We evaluated the effectiveness of phenethyl alcohol (PEA), eyespots, magnetic fields, and avian-predator effigies to deter European starlings (*Sturnus vulgaris*) from nesting in artificial cavities in Ohio during 1993, 1995, and 1996. Each year, 81 nest boxes attached to utility poles were assigned at random equally among 3 treatments (including control): 1993 - PEA or eyespots, 1995 - magnetic fields of 88 or 118 Gauss, and 1996 - great horned owl or merlin effigy. Starlings nested in 84% (1993), 58% (1995), and 90% (1996) of the boxes. There was no difference ($P \geq 0.13$) among treatments each year in 6-7 measures of starling nesting activity. Four species other than starlings (eastern bluebirds [*Sialia sialis*], house wrens [*Troglodytes aedon*], tree swallows [*Tachycineta bicolor*], and house sparrows [*Passer domesticus*]) occupied 13 (1993), 23 (1995), and 2 (1996) nest boxes. We conclude that PEA, eyespots, magnetic fields ≤118 Gauss, and avian-predator effigies are ineffective as deterrents for starlings nesting in artificial cavities.

14. Clark, L., and J. L. Belant. 1998. Contribution of particulates and pH on cowbirds' avoidance of food treated with agricultural lime. Applied Animal Behavior Science 57:133-144. *Abstract:* Agricultural lime used as a grain coating can be repellent to graniverous birds. However, whether repellency is achieved depends upon the method of preparation. The primary mechanism for mediating repellency is pH. Cowbirds avoid seed coated with agricultural lime (5% wt/wt) when the pH exceeds 12.3. A second underlying component mediating repellency exits that is based on avoidance of particulates. If the particulate seed coating consists of particles sized ~63-150 um, and has a pH of 11.4 or less, the repellent potency is about half that observed for raw unprocessed lime. Together, these data help explain emerging conflicting reports on the efficacy of agricultural lime as a bird-repellent. Finally, short-term data on food and water intake and energy balance suggest that periodic intake of agricultural lime does not adversely affect birds.

15. Dolbeer, R. A., and S. K. Ickes. 1994. Red-winged blackbird feeding preferences and response to wild rice treated with portland cement or plaster. Proceedings of the Vertebrate Pest Conference 16:279-282. *Abstract:* The California wild rice (*Zizania aquatica*) industry considers red-winged blackbirds (*Agelaius phoeniceus*) their most important pest problem. Farmers often have asked if crop-damaging blackbirds can be killed by mixing dry Portland cement or plaster-of-Paris with grain bait. We conducted a series of tests to determine the effect of cement or plaster mixed with wild rice fed to captive redwings and to determine feeding preferences of redwings for wild rice in relation to other grains. Birds would not eat cement- or plaster-treated rice when untreated rice was available and no mortality occurred when birds were offered only treated rice over a 4-day period. Thus, treating grain with cement or plaster will not kill redwings, but cement or plaster might serve as useful bird repellents for seed grain. Proso millet was strongly preferred over wild rice by redwings, indicating millet would be an excellent candidate as a lure crop and as a bait for trapping or for delivering a chemical. Sunflower would perhaps not be preferred bait or lure crop in wild rice areas and cracked corn would not be preferred bait.

16. Dolbeer, R. A., D. F. Mott, and J. L. Belant. 1997. Blackbirds and starlings killed at winter roosts from PA-14 applications: implications for regional population management. Proceedings of the Eastern Wildlife Damage Management Conference 7:77-86. *Abstract:* The surfactant PA-14, registered with the U.S. Environmental Protection Agency in 1973 by the federal Wildlife Services (WS) program, was used for 19 years (1974-1992) for lethal control of roosting blackbirds

(Icterinae) and European starlings (*Sturnus vulgaris*) in the USA. In 1992, the WS program withdrew the registration of PA-14 because of costs required to provide additional EPA-requested data. There were 83 roosts encompassing 178 ha treated with 33,300 L of PA-14 from 1974-1992. An estimated 38.2 million birds (48% common grackles [*Quiscalus quiscula*], 30% European starlings, 13% red-winged blackbirds [*Agelaius phoeniceus*], and 9% brown-headed cowbirds [*Molothrus ater*]) were killed, an average of 2.0 million/year. The annual kill represented $\leq$1.3% of the national winter population of blackbirds and starlings. We found no evidence using North American Breeding Bird Survey (BBS) data that PA-14 applications caused declines in regional breeding populations. Furthermore, there was no evidence of secondary poisoning or other adverse environmental effects from PA-14 applications. If regional population management of blackbirds and starlings is to be implemented to reduce agricultural damage or conflicts with native songbirds, new approaches, such as reproductive control, are needed because PA-14 alone will not be adequate. However, PA-14 could have a role in such regional programs in addition to solving localized roost problems. PA-14 was a useful management tool safely applied in human-populated areas (where most roost problems occur); its reregistration should be considered as part of an integrated management program for blackbirds and starlings.

17. Seamans, T. W., C. D. Lovell, R. A. Dolbeer, and J. D. Cepek. 2001. Evaluation of mirrors to deter nesting starlings. Wildlife Society Bulletin 29(4):1061-1066. *Abstract:* European starlings (*Sturnus vulgaris*) nesting in buildings and structures can cause health, nuisance, and safety problems. We evaluated effectiveness of flashing lights combined with mirrors and mirrors alone as deterrents for starlings nesting in starling nest boxes in northern Ohio, 1998–2000. Each year, 100 nest boxes attached to utility poles were randomly assigned equally among 4 treatments (including untreated boxes): 1998- mirrored (internally placed on the back and 2 sides walls of nest boxes), mirrored with red-flashing lights, and mirrored with green-flashing lights; 1999- convex mirror above entrance hole, convex mirror at back of nest box, and flat mirror at back of nest box; 2000- mirrors on 3 sides with exposed surface areas of 263 cm^2, 527 cm^2, or 790 cm^2. Starlings nested in 67% (1998) and 78% (1999 and 2000) of the nest boxes. In 1998, boxes within the 3 treatments with mirrors, regardless of lights, had fewer nests and fewer nests with eggs, nestlings, or fledglings than did control boxes (P [0.002). Boxes with mirrors and lights had fewer ($P < 0.05$) nestlings than mirrored boxes. No difference was noted in number of fledglings produced/nest with nestlings for each treatment. In 1999 and 2000 there was no difference ($P > 0.25$) among the 4 treatments in proportion of nest boxes with starling nests, eggs, nestlings, and young fledged. However, in 2000, boxes with complete mirror coverage did show the least occupancy rate of the 4 treatments. Mean dates of first egg, clutch size, number of nestlings, and number of fledglings/nest also were similar ($P > 0.06$) among treatments. We conclude that mirrors, although slightly repellent under some configurations, are not a practical method to repel starlings from nesting in structures.

Geese and Miscellaneous Birds

18. Belant, J. L., S. K. Ickes, L. A. Tyson, and T. W. Seamans. 1997. Comparison of four particulate substances as wildlife feeding repellents. Crop Protection 16:439-447. *Abstract:* We compared the effectiveness of dolomitic lime, activated charcoal, Nutra-lite (a silica-based compound), and white quartz sand as feeding repellents for brown-headed cowbirds (*Molothrus ater*), white-tailed deer (*Odocoileus virginianus*), and Canada geese (*Branta canadensis*). In 4 day, 2-choice aviary tests with cowbirds, consumption of treated millet (1% to 4% g/g) was less ($P < 0.01$) than consumption of untreated millet for all particulates except Nutra-lite at 1% g/g. Greatest reductions in consumption occurred with lime-treated millet, followed by charcoal, Nutra-lite, and sand. Overall mean daily consumption of treated millet by cowbirds in 1-choice tests was similar ($P > 0.05$) to total consumption of millet in comparable 2-choice tests for each particulate. However, millet treated with 4% lime reduced cowbird consumption for 1 day. Similarly, in 4-day, 2-choice tests field tests involving free-ranging deer, deer consumed less corn treated (4% g/g) with lime or charcoal than corn treated with Nutra-lite or sand. Corn treated with sand did not reduce ($P = 0.44$) consumption by deer relative to untreated corn. Lime applied to turf in 10- x 21-m enclosures at an application rate of 270 kg/ha did not suppress grazing by geese. Nutra-lite applied to turf at the manufacturer-recommended rate of 2,568 kg/ha reduced overall goose presence on treated plots in enclosures for 3 days but suppressed goose grazing for 1 day only. We conclude that lime is more effective overall as a white-tailed deer and brown-headed cowbird feeding repellent than is charcoal, Nutra-lite, or sand. Lime has considerable potential as a feeding repellent in agricultural and possibly turf situations. Charcoal could be used effectively in situations where lime is impractical.

19. Belant, J. L., and T. W. Seamans. 1999. Alpha-chloralose immobilization of rock doves in Ohio. Journal of Wildlife Diseases 35:239-242. *Abstract*: The effectiveness of 3 dosages (about 60, 120 and 180 mg/kg) of alpha-chloralose (AC) were compared for immobilizing pigeons (*Columba livia*). Responses to immobilization using about 180 mg/kg AC also was compared in pigeons food deprived for 24 hr and not food deprived. Mean ($\pm$ SE) time to first effects (33 $\pm$ 2 min) and mean time to capture (94 $\pm$ 5 min) was significantly less for pigeons receiving 180 mg/kg than for pigeons receiving lower dosages ($\geq$53 $\pm$ 3 min and $\geq$153 $\pm$ 17 min, respectively). Ten, 10 and 8 pigeons immobilized with 60, 120 and 180 mg/kg AC recovered within 24 hr, respectively; all pigeons recovered within 29 hours. Although food-deprived pigeons showed effects of AC immobilization earlier than did pigeons with food, time to capture was similar between these 2 groups. This new formulation should improve capture success of pigeons substantially and improve the ability to resolve nuisance pigeon problems.

20. Belant, J. L., T. W. Seamans, L. A. Tyson, and S. K. Ickes. 1996. Repellency of methyl anthranilate to pre-exposed and naive Canada geese. Journal Wildlife Management 60:923-928. *Abstract:* To improve our understanding of the effectiveness of avian feeding repellents, we evaluated whether Canada geese (*Branta canadensis*) exhibited learned avoidance of ReJeX-iT AG-36 (AG-36), a methyl anthranilate (MA) formulation containing 14.5% MA (vol/vol). During 2 experiments in August-September 1995, we pre-exposed geese orally to 0.0, 1.3, or 4.0 g AG-36 and released them onto 10- x 10-m grass plots treated with AG-36 at rates of 22.6 and 67.8 kg/ha. Mean numbers of bill contacts and mean numbers of geese observed on control and treated plots were similar ($P \geq 0.21$) for geese pre-exposed or naive to AG-36. Overall, mean numbers of bill contacts and mean numbers of geese also were similar ($P \geq 0.56$) on control and treated plots. Mean mass of droppings on control and treated plots was similar ($P > 0.99$) during the experiment with 22.6 kg/ha AG-36 but was greater ($P = 0.01$) on control plots during the experiment with 67.8 kg/ha AG-36. We conclude that learned avoidance of AG-36 by Canada geese pre-exposed orally to 1.3 or 4.6 g AG-36 did not occur and that AG-36 applied to turf in enclosures at rates of 22.6 and 67.8 kg/ha was not effective as a grazing repellent for geese.

21. Belant, J. L., L. A. Tyson, T. W. Seamans, and S. K. Ickes. 1997. Evaluation of lime as an avian feeding repellent. Journal of Wildlife Management 61:917-924. *Abstract:* We evaluated the effectiveness of dolomitic hydrated lime as a feeding deterrent to captive brown-headed cowbirds (*Molothrus ater*) and Canada geese (*Branta canadensis*) during July-September 1995. We conducted 1- and 2-choice tests using grains with caged cowbirds and geese, and applications of lime to turf in dry and slurry form for geese. Lime mixed with millet or whole-kernel corn at 25, 12.5, and 6.25% (g/g) reduced cowbird and goose feeding in 4 day, 2-choice (treated or untreated grain) cage trials. Reductions in total food intake occurred for both species during similar 1-choice tests with lime (25% [g/g]) and millet or corn. Body mass of cowbirds and geese increased or remained constant during 2-choice tests. In contrast, body mass declined for both species during 1-choice tests. Application of lime to enclosed 10- x 10-m-grass plots in powder or slurry form at an application rate of 544 kg/ha also reduced goose feeding on treated plots for 2-3 days. Mean numbers of geese and mean fecal mass on control and treated plots were similar during both turf experiments. No phytotoxicity of grass was observed $\geq$40 days post treatment. We recommend additional studies to determine the lower limit of repellency of lime to various bird species and its utility for turf and crop damage reduction.

22. Blackwell, B. F., G. E. Bernhardt, and R. A. Dolbeer. 2002. Lasers as non-lethal avian repellents. Journal of Wildlife Management 66(1):250-258. *Abstract:* Lasers have been demonstrated to be potentially effective avian repellents; however, studies combining adequate controls and replication that test such applications of lasers in wildlife management have not been reported. We conducted 2-choice cage tests to quantify the effectiveness of a 10-mW, continuous wave, 633-nm laser as a visual repellent (treating a perch) against brown-headed cowbirds (*Molothrus ater*) and European starlings (*Sturnus vulgaris*), and a 68-mW, continuous wave, 650-nm laser in dispersing (i.e., targeting birds with the laser) starlings and rock doves (*Columba livia*) from perches and Canada geese (*Branta canadensis*) and mallards (*Anas platyrhynchos*) from grass plots. All experiments were conducted under low ambient light ($\leq$3 lx) conditions. In 3 experiments with stationary and moving laser beams treating a randomly selected perch, brown-headed cowbirds were not repelled. Similarly, a moving beam did not repel European starlings from treated perches, nor were they dispersed when targeted. Rock doves exhibited avoidance behavior only during the first 5 min of 6 80-minute dispersal periods. Notably, 6 groups of geese (4 birds/group) exhibited marked avoidance of the beam during 20-min periods ($n = 23$), with a mean 96% of birds dispersed from laser-treated plots. Six groups of mallards (6 birds/group) were also dispersed (*x*= 57%) from treated plots during 20-minute periods (*n* = 12), but habituated to the beam after approximately 20 min. We contend that lasers will prove useful as avian repellents, but further controlled studies are needed to evaluate species-specific responses relative to laser power, beam type, wavelength, light conditions, and captive versus field scenarios.

23. Blackwell, B. F., T. W. Seamans, and R. A. Dolbeer. 1999. Plant growth regulator enhances repellency of anthraquinone formulation to Canada geese. Journal of Wildlife Management 63:1336-1343. *Abstract:* There is a need for nonlethal methods of reducing conflicts between burgeoning populations of resident Canada geese (*Branta canadensis*) and humans at airports and other settings. An anthraquinone-based formulation (Flight Control™ [FC], 50% anthraquinone [AQ], active ingredient) has shown promise in deterring grazing by Canada geese. We hypothesized that the addition of a plant growth regulator (Stronghold™ [SH]) might enhance the effectiveness of FC by minimizing the exposure of new, untreated grass. To isolate the effects of grass height, plant growth regulator, and the combination of a repellent with a plant growth regulator on grazing by geese, we conducted 3 experiments, each using 24 geese in 6 18 x 31-m pens, in northern Ohio during 1998. We evaluated the response of geese to short (4-11 cm) and tall grass (16-21 cm) in a 9-day test. Next, SH (applied at 1.2 L/ha) was evaluated as a grazing repellent in a 14-day test. Finally, we evaluated the effectiveness of FC (2.3 L/ha), combined with SH (0.9 L/ha SH), as a grazing repellent in a 22-day test. We found no difference (*P* = 0.53) in the number of geese per observation in tall- (1.7 ± 1.5; $\bar{x}$ ± SE) and short-grass plots (2.3 ± 1.5), nor in bill contacts per minute (*P* = 0.78) in tall- (12.6 ± 9.3) versus short-grass plots (11.1 ± 7.9). In the SH test, 14 days post application, mean grass height was 12.9 cm in untreated plots and 7.2 cm in treated plots. However, the number of geese per observation on untreated (1.8 ± 1.3) and treated plots (2.2 ± 1.3) did not differ (*P* = 0.57). Also, there was no difference (*P* = 0.71) in the number of bill contacts per minute in untreated (15.3 ± 9.9) and treated plots (18.1 ± 14.2). In contrast, over a 22-day FC/SH test, the mean number of geese per observation was 2.6 times greater (*P* < 0.01) on untreated (2.9 ± 0.5) than on treated plots (1.1 ± 0.5). Further, the mean number of bill contacts per minute was 8.2 times greater (*P* < 0.01) on untreated (54.4 ± 11.2) than treated plots (6.6 ± 2.3). We observed no abatement in repellency 22 days post treatment. Thus, we conclude that SH greatly enhanced the repellency of FC to grazing Canada geese. The use of a plant growth regulator with FC should reduce goose foraging on turf.

24. Dolbeer, R. A., J. L. Belant, and L. Clark. 1993. Methyl anthranilate formulations to repel birds from water at airports and food at landfills. Proceedings of the Great Plains Wildlife Damage Control Conference 11:42-53. *Abstract:* We conducted 2 sets of experiments to evaluate methyl anthranilate (MA) as an avian repellent. The first set (May-Aug 1991) evaluated 2 Rejex-It™ formulations of MA applied to water at John F. Kennedy International Airport (JFKIA), New York. Our second set of experiments (Aug-Sep 1992) tested the hypothesis that MA mixed with a landfill cover material (ConCover 180R)) would reduce consumption by birds when applied to food in a controlled environment (captive birds in cages). At JFKIA, fewer birds were seen in treated standing water than in untreated water, which supported results obtained in previous cage trials. In the landfill cover experiments, MA was repellent to cowbirds and ring-billed gulls at food sources, although a higher concentration (0.5% MA) was required to repel ring-billed gulls than cowbirds (0.15% MA). Cowbirds were repelled by similar concentrations of MA during tests using millet mixed with ConCover 180[R]. MA appears promising as a bird repellent when applied to standing water and may help deter birds from feeding in landfills when incorporated into a landfill cover material such as ConCover.

25. Dolbeer, R. A., T. W. Seamans, B. F. Blackwell, and J. L. Belant. 1998. Anthraquinone formulation (Flight Control) shows promise as avian feeding repellent. Journal of Wildlife Management 62:1557-1563. *Abstract:* We evaluated the effectiveness of Flight Control™ [FC] (50% anthraquinone [AQ]) as a grazing repellent for Canada geese (*Branta canadensis*) and as a seed-treatment repellent for brown-headed cowbirds (*Molothrus ater*) in northern Ohio in 1997. For the turf test, FC was applied at 4.5 L/ha in 6 18.3- ∗ 30.5-m pens. There were 2.5 times more ($P < 0.01$) bill contacts/min observed on untreated plots (26.4 ± 6.0; $\bar{x}$ ± SE) compared to treated plots (10.4 ± 3.8) during a 7-day test with captive geese. Mean numbers of geese per observation were also greater ($P = 0.02$) on untreated plots (2.6 ± 0.4) compared to treated plots (1.4 ± 0.4). Residue analyses indicated AQ declined from 2.02 kg/ha at application to 0.22 kg/ha after 1 week. Individually caged cowbirds were presented untreated millet or millet treated with FC at 0.1, 0.5 and 1.0% (g/g) levels in 1- and 2-choice tests for 3--4 days. Flight Control™ was repellent to cowbirds at all levels in both 1- and 2-choice tests. In the 2-choice test, birds in the 1.0% treatment level lost body mass ($P = 0.04$), whereas birds at the other levels did not. Each group of treated birds in the 1-choice test lost mass ($P \leq 0.01$), whereas the control group did not. Birds in the 0.5 and 1.0% groups ate minimal amounts; 3 of 12 birds died. We conclude that FC was an effective foraging repellent for Canada geese in a 7-day pen experiment and for brown-headed cowbirds as a seed repellent in aviary experiments. Flight Control™ shows promise as an avian feeding repellent. Further lab and field studies are needed to refine minimum repellent levels and to enhance retention of AQ on treated vegetation.

26. Seamans, T. W. 2004. Response of roosting turkey vultures to a vulture effigy. Ohio Journal of Science 104:136-138. *Abstract:* Increasing populations of turkey vultures (*Coragyps atratus*) and black vultures (*Cathartes aura*) cause concerns for human health and safety in areas where large roosting concentrations occur. Dead bird effigies are one proposed method of dispersing roosting vultures. In 1999 and 2000, tests were conducted using a supine and hanging turkey vulture effigy (a taxidermy mount) to disperse a vulture roost in a tower in northern Ohio. In all tests, fewer (*P* [0.04) vultures were observed in the roost during the treatment period when compared to the pretreatment period. In tests ending in fall migration the posttreatment period differed ($P < 0.01$) from the pretreatment period. In tests ending in summer the pre- and posttreatment periods did not differ ($P > 0.23$). Vulture effigies are promising tools that may be used as part of integrated programs to disperse vultures from problem roosting sites.

27. Seamans, T. W., and G. E. Bernhardt. 2004. Response of Canada geese to a dead goose effigy. Pages 104-106 in Proceedings of the 21st Vertebrate Pest Conference. University of California, Davis. *Abstract:* The North American Canada goose population increased at a rate of 10.5%/year, 1966 - 2001. Canada geese rank as the third most hazardous species in regards to collisions with aircraft. Sound Canada goose management tools are critical for a safer airport environment. We conducted field evaluations of a Canada goose effigy during the breeding season with territorial pairs and with post-fledging flocks in late summer to determine if geese were deterred by the effigy. No difference in territorial pairs was found between pretreatment and treatment periods for Canada geese when goose effigies were placed within their territories. In post-fledging flocks the mean number of geese observed during pretreatment (74.9 ± 12.9), treatment (14.8 ± 4.5), and post treatment (53.6 ± 14.2) periods differed ($P < 0.01$). There was no difference ($P = 0.56$) between the mean number of geese observed during a second round of 5-day pretreatment (58.7) and 5-day second round treatment (43.7) periods. By itself, the goose effigy was not effective as a Canada goose deterrent after approximately 5 days. However, this effigy may have some potential in an integrated goose control program conducted outside of the breeding season. Further evaluation of the effigy as part of an integrated Canada goose control program is recommended.

28. Seamans, T. W., B. F. Blackwell, and J. T. Gansowski. 2002. Evaluation of Allsopp Helikite as a bird scaring device. Proceedings of the Vertebrate Pest Conference 20:129-134. *Abstract:* We evaluated the effectiveness of Allsopp Helikites as a gull (*Larus* spp.) deterrent at loafing and nesting areas and as a bird deterrent in a sunflower field. In 1998, a 10-day trial was conducted at 2 0.5 ha ponds at the Erie County, Ohio landfill (EC) and a 2-week trial on 2 0.1 ha plots on the Tru-Serv Corporation (TSC) warehouse roof in Cuyahoga County, Ohio. Also in 1998, a 5-week trial in a sunflower field was conducted in Erie County, Ohio. In 1999, a 24-day trial was conducted at the Service Liqueur Distributors (SLD), Inc. warehouse roof, 1.6 km from the Albany, NY landfill. At the EC LANDFILL the mean number (± SE) of ring-billed (*L. delawarensis*) and herring gulls (*L. argentatus*) on the treated pond decreased ($P < 0.05$) from 421 ± 292 to < 1 after Helikite deployment. Whereas the mean number of gulls on the untreated pond increased ($P < 0.05$) from 73 ± 135 to 412 ± 456. At the TSC roof, the herring gull nest density differed ($P < 0.01$) between areas covered and not covered by Helikites. Nest density under Helikites decreased from 41/ha to 18/ha within 7 days of deployment. Nest density in areas not covered by Helikites increased from 23/ha to 42/ha within 14 days of deployment. At the SLD warehouse, when Helikites were not in place, the mean number (! SD) of gulls on the roof was 41 (! 38). When Helikites were in place, no gulls were observed on the roof at any time. Mean damage to sunflower heads remained similar in the Helikite-treated and untreated plots until the last week of measurement when damage in the untreated plot increased to 26 % seed loss/head whereas damage in the treated plot remained at about 8 %. Helikites are a high-maintenance tool and are limited by weather conditions, electrical lines and structures that can damage Helikites. We conclude that Allsopp Helikites have the potential to deter gulls from preferred loafing and nesting areas and could be included as part of an integrated management program to disperse gulls. Further research on Helikites is needed to determine optimum deployment heights, habituation rates for gulls and other species and the actual sphere of influence of the kite for various species.

29. Woronecki, P. P., R. A. Dolbeer, T. W. Seamans, and W. R. Lance. 1992. Alpha-chloralose efficacy in capturing nuisance waterfowl and pigeons and current status of FDA registration. Proceedings of the Vertebrate Pest Conference 15:72-78. *Abstract:* During 1990 and 1991 we conducted safety, efficacy and clinical trials required to register alpha-chloralose (A-C) for capturing nuisance waterfowl and pigeons with the U.S. Food and Drug Administration (FDA). We determined the Most Effective Dose (MED) to be 30 and 60 mg of A-C/kg of body weight for capturing waterfowl and pigeons, respectively. We conducted 11 field trials in 4 states, capturing 587 waterfowl and 1,370 pigeons with 8% mortality for ducks, 0% for geese, and 6% for pigeons. We submitted a New Animal Drug Application to FDA in October 1991 and received registration in 1992 for use of A-C by Wildlife Services biologists.

DEER

30. Belant, J. L. and T. W. Seamans. 2000. Comparison of three devices to observe white-tailed deer at night. Wildlife Society Bulletin 28(1):154-158. *Abstract:* To further reduce deer-aircraft collisions, a method for observing deer on airports at night that does not affect aircraft operations is required. We compared the effectiveness of forward-looking infrared (FLIR), spotlight, and night vision goggles (NVG) to monitor the abundance of white-tailed deer (*Odocoileus virginianus*) along a 10-km route in Ohio during 12 nights in winter (Jan-Feb) and summer (Jul) 1997. Numbers of deer observed with FLIR (825 in winter, 570 in summer) and spotlight (716 and 445) were similar ($P>0.05$); number of deer observed with NVG (243 and 152) was less ($P<0.05$) in winter and summer. The FLIR provided the best overall observability of deer of the 3 devices tested. The FLIR was less affected than spotlights by inclement weather and was not obtrusive. Biologists working in suburban areas or on airports can use FLIR to detect deer in areas where a spotlight would be inappropriate. Under conditions tested, we do not recommend using NVG to detect white-tailed deer at night.

31. Belant, J. L., T. W. Seamans, and C. P. Dwyer. 1996. Evaluation of propane exploders as white-tailed deer deterrents. Crop Protection 15:575-578. *Abstract:* In response to increased white-tailed deer (*Odocoileus virginianus*) depredation of agricultural crops and encroachment on airports, we evaluated the effectiveness of systematic and motion-activated propane exploders as deer frightening devices. We conducted 3 experiments in a 2200-ha fenced facility in northern Ohio with high (91/km^2) deer densities during 1994-1995. Systematic exploders were calibrated to detonate once at 8- to 10-minute intervals whereas motion-activated exploders detonated 8 times/deer intrusion. Systematic propane exploders were generally ineffective, deterring deer from corn for $\leq$2 days only, whereas motion-activated exploders repelled deer for 0-6 weeks. Repellency of motion-activated exploders varied seasonally, possibly in response to variations in deer density, availability of alternate food, or reproductive and social behavior. We recommend motion-activated exploders over systematic exploders as deer frightening devices for crop damage mitigation and on airports; however, systematic exploders may have utility for short-term (a few days) use.

32. Belant, J. L., T. W. Seamans, and C. P. Dwyer. 1998. Cattle guards reduce deer crossings through fence openings. International Journal of Pest Management 44:247-249. *Abstract:* In response to increased white-tailed deer (*Odocoileus virginianus*) encroachment on airports, we evaluated the effectiveness of cattle guards as deer exclusion devices. We conducted 3 experiments in a 2,200 ha fenced facility in northern Ohio with high (91/km^2) deer densities during 1994-1995. During each experiment, we monitored deer crossings at 2-3 cattle guards (4.6 [L]x3[W]x0.5 or 1.0[D] m) constructed at fence openings for 2 weeks pre- and post-installation. For each experiment, the mean daily number of deer crossings after installation of cattle guards was reduced ($P < 0.01$) by $\geq$88% compared to respective crossing rates during pretreatment. Reductions in deer crossings using cattle guards with 0.5 or 1.0 m deep excavations were similar (95-96% vs. 98%) overall. Cattle guards at permanent openings used for vehicular traffic appear a viable technique to exclude deer from fenced airports and other facilities where deer exclusion is desired.

33. Belant, J. L., T. W. Seamans, and L. A. Tyson. 1997. Evaluation of three electronic frightening devices as white-tailed deer deterrents. Proceedings of the Vertebrate Pest Conference 18:107-110. *Abstract:* We evaluated the effectiveness of the motion-activated Usonic Sentry (with and without strobe), motion-activated Yard Gard, and Electronic Guard for deterring white-tailed deer (*Odocoileus virginianus*) from preferred feeding areas during February-April 1996. We conducted 2 4-week experiments, monitoring deer use (number of intrusions and corn consumption) at 8 feeding stations in a 2,200-ha fenced facility in northern Ohio with high deer densities ($\geq$38/km^2). During these experiments, we positioned 1 of the devices at each of 4 sites. The mean ($\pm$ SE, n = 4) daily number of deer intrusions at feeding stations during treatment (96.5 $\pm$ 12.6-169.0 $\pm$ 22.0) was similar ($P \geq 0.13$) to or greater ($P \leq 0.04$) than the mean daily number of deer intrusions during pre- or posttreatment (109.8 $\pm$ 15.6-148.8 $\pm$ 21.4). Corn consumption declined ($P < 0.05$) only at stations with Usonic Sentrys without strobes for 1 week. We conclude that the electronic frightening devices tested were generally ineffective in deterring white-tailed deer from preferred feeding areas.

34. Belant, J. L., T. W. Seamans, and L. A. Tyson. 1997. Predator urines do not deter white-tailed deer from feeding areas or trails. Proceedings of the Vertebrate Pest Conference 18:359-362. *Abstract:* We assessed whether bobcat (*Lynx rufus*) or coyote (*Canis latrans*) urine could reduce white-tailed deer (*Odocoileus virginianus*) use of established feeding areas or trails. A 4-week experiment evaluating deer use of 8 feeding stations, 4 each with coyote or bobcat urine was conducted at a 2,200-ha fenced facility in northern Ohio with high deer densities (38/km^2). At this same facility, we also monitored deer use of 4 trails where coyote urine was applied. For both experiments, urine was placed in holders positioned at ground level within 2 m of the area being protected . The number of deer entering feeding stations after 2 weeks exposure to predator urines was 15-24% less ($P \leq 0.05$) than the number of deer entering feeding stations during pretreatment. Deer use of trails did not decrease in response to presence of coyote urine. We conclude that predator urines used as a chemical barrier were of limited effectiveness in deterring high concentrations of white-tailed deer from areas with established sources of food and ineffective in deterring deer from trails.

35. Belant, J. L., L. A. Tyson, T. W. Seamans, and S. K. Ickes. 1997. Mylar flags do not deter white-tailed deer from feeding areas. Journal Wildlife Research 2:210-212. *Abstract:* We evaluated the effectiveness of mylar flags for deterring white-tailed deer (*Odocoileus virginianus*) from feeding areas during December 1996. We conducted a 3-week experiment, monitoring deer use (number of intrusions and corn consumption) at 10 feeding stations in a 2,200-ha fenced facility in northern Ohio with high deer densities (>21/km^2). We positioned 2 mylar flags (15 cm x 1 m) attached to lathe at each of 5 sites; remaining sites received lathe only (untreated). Mylar flags did not reduce ($P \geq 0.43$) the number of deer intrusions into feeding stations or the amount of corn consumed relative to feeding stations without mylar flags. We conclude that mylar flags are ineffective for deterring white-tailed deer from feeding areas during winter.

36. Seamans, T. W., B. F. Blackwell, and J. D. Cepek. 2002. Coyote hair as an area repellent for white-tailed deer. International Journal of Pest Management 48(4):301-306. *Abstract:* Increasing white-tailed deer (*Odocoileus virginianus*) populations create numerous conflicts with agricultural production and transportation safety. Lethal control is not always an option and area repellents, such as predator waste products, have generally shown limited effectiveness. We tested coyote (*Canis latrans*) hair as a repellent at feeding stations during the winters of 2000 and 2001 and along established deer trails during the summer of 2000 in northern Ohio. Feeding station experiments were conducted in which five treatment sites received one or three bags containing 17 g of coyote hair placed adjacent to or in front of a trough of whole kernel corn and five control sites received empty bag(s). In all feeding trials, corn consumption decreased at treated sites from 59 - 91%. Intrusions by deer at treated sites decreased by 48 - 96% in three tests but did not vary in the first 3-week test when coyote hair was adjacent to the corn. Corn consumption and deer intrusions at control sites generally remained constant or showed an increase over the test period. In the deer trail test, use of trails did not differ between the pre-treatment and treatment periods for the control or treated trails. Coyote hair therefore served as an effective repellent to keep deer from a desired food source and should have utility in protecting limited, discrete sites. However, coyote hair did not deter deer from moving along established trails.

HABITAT MANAGEMENT AND MISCELLANEOUS

37. Barras, S. C., M. S. Carrara, R. A. Dolbeer, R. B. Chipman, and G. E. Bernhardt. 2000. Bird and small mammal use of mowed and unmowed vegetation at John F. Kennedy International Airport, 1998 to 1999. Proceedings Vertebrate Pest Conference 19:31-36. *Abstract:* We evaluated bird and small mammal use of two mowed (15 to 25 cm height) and two unmowed vegetation plots (40 to 88 ha) at John F. Kennedy International Airport (JFKIA), New York, in 1998 to 1999 to determine which management strategy would best reduce wildlife use of the airport. We counted more birds per 5-minute observation period in unmowed plots than mowed plots in both 1998 (9.0 versus 7.9) and 1999 (11.7 versus 8.6). Maximum vegetation height was greater ($\underline{P}<0.05$) for unmowed areas than mowed areas after mowing commenced in 1998 and 1999 for each two-week monitoring period. In 1998 to 1999, vegetation density was also higher ($\underline{P}<0.05$) for unmowed plots for 13 of 14 sampling periods. The species composition of vegetation differed ($\underline{X}^2$=20.54, df=3, $\underline{P}$<0.01) among mowed and unmowed plots. Mowed plots contained a higher percentage of grasses (81% versus 68%), and a lower percentage of forbs (16% versus 25%) and woody plants (1% versus 4%) than unmowed plots. Vegetation was generally sparse in both unmowed and mowed plots, a consequence of the poor, sandy soils on much of the airport. We captured 33 small mammals from three species in unmowed plots and 12 individuals of one species in mowed plots in 1999. Small mammal populations increased seasonally in unmowed plots, but remained constant in mowed plots over the same time period. We recommended JFKIA switch from the unmowed vegetation management regime in place since 1986 to a regime of maintaining vegetation mowed at 15 to 25 cm height. This management strategy should reduce bird and small mammal use of grassland areas at JFKIA. Further research should examine use of alternative vegetation types to improve ground cover and vegetation density at JFKIA while minimizing attraction to wildlife.

38. Barras, S. C. and T. W. Seamans. 2002. Habitat management approaches for reducing wildlife use of airfields. Proceedings of Vertebrate Pest Conference 20:309-315. *Abstract:* Wildlife-aircraft collisions (wildlife strikes) pose safety risks to aircraft and cost civil aviation over $390 million annually in the USA. We reviewed published studies to summarize findings on habitat management techniques that have shown potential for wildlife strike reduction. Habitat components that may attract wildlife to airports include food, cover, water, and loafing areas. Although maintaining tall herbaceous vegetation on airfields may reduce the attractiveness of loafing and feeding sites for some species of birds such as gulls, this strategy may also increase cover and food resources for other hazardous species. Thus, optimum vegetation height management strategies require further research and may be site-specific. Replacing attractive vegetation with less palatable vegetation has also been recommended, but studies with widespread application are lacking. Removal of ornamental trees and shrubs reduces cover for deer and small mammals and nesting sites for birds while also reducing availability of perches. However, exclusion techniques are also needed for reducing the availability of artificial perches and water. Despite more than 30 years of substantive discussion on the importance of these habitat management techniques, few reliable studies of the effectiveness of these techniques have been conducted under operational airport conditions.

39. Gabrey, S. W., and R. A. Dolbeer. 1996. Rainfall effects on bird-aircraft collisions at two United States airports. Wildlife Society Bulletin 24:272-275. *Abstract:* We examined the influence of rainfall on bird-aircraft collisions at 2 major United States airports. Presence of standing water from rainfall did not increase the probability of bird-aircraft collisions at John F. Kennedy International airport during April-October, 1986-1990. However, at O'Hare International Airport there was evidence that standing water increased collision rates. During April-October 1992-1994, collision rates were higher 1 day after $\geq$2.54 cm rain than at other times. Although this analysis showed no clear-cut influence of rainfall on bird-aircraft collisions, airport operations personnel, as precautionary measures, should continue efforts to remove standing water and deter bird use of puddles. Detailed long-term data on daily bird-aircraft collisions, rainfall, and bird use of standing water are needed from other airports so that a more comprehensive and generalized analysis of collisions in relation to rainfall can be made.

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APPENDIX M:
A Wetland Banking Mitigation Strategy For FAA

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A WETLAND BANKING MITIGATION STRATEGY FOR FAA

JULY 1996

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PREFACE.

This document describes the concept of wetland mitigation banking and how the FAA and airport sponsors can use this newly accepted mitigation strategy to more efficiently meet Section 404 permit requirements and environmental responsibilities. Wetland mitigation banking, although not a new ecological idea, is rapidly gaining support from all levels of government and private developers because it offers a proven, cost-effective way to compensate successfully for unavoidable wetland impacts. An example of this recent acceptance is the November 28, 1995, joint issuance of wetland banking guidance by five federal agencies that once held widely divergent views on wetland banking.

This document does not provide instructions on implementing a wetland banking strategy, since each FAA service has specific operating procedures to accomplish its respective mission. Instead, this document provides information and "ground rules" that each service should follow as it "custom designs" wetland banking instructions that meet the service's particular needs.

This document does not discuss building a wetland bank, but, instead, emphasizes and provides information on purchasing credits from an agency or person or "banker" operating such a facility. Operating a wetland bank requires extensive knowledge of complex wetland management techniques and specially trained personnel. Since the primary mission of the FAA and airport sponsors is aviation, the purchase of credits from a wetland banker frees the FAA and airport sponsors to concentrate on the complex business of managing aviation, not the complex business of managing wetlands. Anyone wishing to build a wetland bank should contact environmental specialists in the Office of Airports (202-267-5869) or the regional Army Corps of Engineers (COE) office for information.

I. WHAT IS WETLAND MITIGATION BANKING?

Wetland mitigation banking provides a way to mitigate unavoidable wetland impacts <u>before</u> those impacts occur. Purchasing credits from a bank does not give the purchaser title to wetlands tracts that comprise a bank. Rather, the purchase is simply a payment to the wetland banker for wetland mitigation services that the bank provides.

To establish a wetland bank, the banker owning and/or managing the bank can restore, enhance, or create wetlands within a watershed or region. Implementing one of these measures or a combination of them is necessary to replace the wetland functions lost due to constructing a project within a wetland. In rare instances, preserving existing, high quality wetlands is an acceptable banking plan, but this is rarely the case because it does not truly meet the President's "no net loss" policy for wetlands. Once a bank is established and the COE has approved the bank's use, the banker is allowed to sell credits from the bank to 404 permittees (see section II). The sale of credits from a bank signifies that the bank is capable of:

• replacing wetland functions in a watershed where unavoidable development of a wetland occurs; or

• providing wetland functions that are necessary to achieve a designated wetland management plan in the affected watershed.

II. Why Would The FAA Or Airport Sponsor Want To Use Wetland Mitigation Banking?

Section 404 of the Clean Water Act requires any one seeking authority to dredge and/or fill a wetland (404 permittee) to obtain a Section 404 permit before conducting those activities. One of the steps in the 404 permit application process requires the permit applicant to show that the proposed action includes ways to minimize unavoidable wetland impacts. This is where wetland banking plays a role.

If the COE issues a 404 permit authorizing dredge and/or fill activities in a wetland, that permit will probably contain requirements compelling the permittee to implement a plan to reduce the project's unavoidable wetland impacts. Because wetlands are ecologically complex and dynamic, the development of a wetland mitigation plan capable of replicating or replacing lost functions is often the most difficult and time consuming step of the 404 permit process. For most aviation-related projects built in wetlands, the FAA program office or the airport sponsor, as the permittee, is responsible for complying with permit required mitigation measures. Wetland banking will help FAA program offices and airport sponsors to satisfy 404 permit conditions in a cost-effective and efficient manner.

Wetland banking will enable the FAA to achieve the President’s regulatory streamlining efforts and to achieve the Administration's long-term goal of increasing the quality of the Nation's wetlands. In addition, wetland mitigation banking has the following potential benefits:

• Banking can increase the quality of the Nation's wetlands.

• Banking is part of DOT's strategy to take a pro-active approach in

addressing environmental issues and improving its working relationships with federal, state, local, and private agencies responsible for protecting wetlands.

• Banking provides FAA program offices and airport sponsors with a strategy for satisfying resource agency demands and mitigating wildlife and wetland impacts, while reducing wildlife and bird hazards to aviation.

• Because banking enhances the probability that FAA or an airport sponsor will obtain Section 404 permits in a more timely manner, the FAA or airport sponsor would be better able to meet tight construction deadlines more often and to complete essential projects more quickly.

• The purchase of credits from a wetland bank absolves the FAA or a project sponsor of the responsibility for undertaking, monitoring, and maintaining a complex, often difficult, wetland mitigation plan. As a result, the FAA and the airport sponsor can focus primarily on aviation needs, not on managing a wetland.

- Since the price of credits from a particular bank are known, banking can greatly enhance the ability of FAA program offices or airport sponsors to estimate the financial costs of mitigating unavoidable project-related wetland impacts.

III. Is Wetland Mitigation Banking New To The FAA?

Yes, but it isn't new to land developers, who have used wetland banks for the past 10 to 15 years. What is new is the acceptance of wetland banking by state governments and federal agencies. These parties now realize that wetland banking offers far greater ecological benefits than many of the on-site strategies commonly used today to mitigate wetland impacts. Examples of this new way of thinking are:

- The development of regulations and guidelines governing wetland banking by the federal government and the states of California, Florida, Maryland, Minnesota, and Oregon.

- The commitment of The Urban Land Institute, an organization of federal and state agencies, private land developers, and environmental groups, to provide administrative support, expertise, and a forum that allows interested parties to discuss openly and constructively their respective wetland mitigation banking concerns and problems.

- The Administration's commitment to wetland banking by convening a federal inter-agency task force that developed mutually acceptable banking guidelines.

- The Federal Highway Administration's (FHWA) program to encourage the use of wetland banks for roadway projects and its issuance of banking guidelines.

- FHWA's financial participation in the establishment of wetland mitigation banks for highway projects throughout the USA.

- The purchase of thousands of wetland acres in Florida by aviation departments to mitigate project-related wetland impacts.

- The State of Florida's acceptance of the Walker Ranch Bank to show that a privately financed bank can be used to mitigate successfully unavoidable impacts to thousands of acres of Florida wetlands.

IV. Banking Sounds Like A Good Idea.

In response to the President's support for wetland banking, the COE, the National Resources Conservation Service (formerly the Soil Conservation Service), EPA, the U.S. Fish and Wildlife Service, and the National Marine Fisheries Service have embraced wetland banking and have issued final guidelines (*Federal Register*, Vol. 60, No. 228, November 28, 1995). California, Florida, Minnesota, and other states have recognized the value of banking and actively promote it.

To protect wetlands, Executive Order 11990 and various regulations require 404 permit applicants to ensure that federal agencies complete the sequencing procedure (item VII). This safeguard should suffice to ensure that the selected wetland site is truly the only practicable alternative that would meet a proposed project's specifications, purpose, and need. In addition, the inter-agency wetland mitigation banking guidelines require the COE and other federal resource agencies to oversee the permit process to ensure that sequencing occurs and to ensure that the banks successfully mitigate wetland impacts.

V. ARE FAA PROGRAMS OR AIRPORT SPONSORS REQUIRED TO USE WETLAND MITIGATION BANKING FOR ALL ACTIONS AFFECTING WETLANDS?

No. Banking is strictly a voluntary way to satisfy wetland mitigation requirements. The FAA and airport sponsors may continue to engage in more traditional wetland mitigation approaches. Different mitigation strategies may be pursued for different programs or projects. Appropriate wetland banks may not always be available. In summary, each FAA program office or airport sponsor has the option of using or not using wetland banking for each project under its purview.

If the 404 permit applicant chooses to use wetland mitigation banking, he/she may consider two options:

- Under option one, the 404 permit applicant may propose to build a wetland bank within the same watershed as the proposed project and use credits from that bank to mitigate unavoidable wetland impacts resulting from proposed and future actions. The COE must approve the use of the banked credits as mitigation for wetland functions or values lost due to each particular project. In this situation, the permittee is responsible for wetland success.

Note: FAA offices and airport sponsors are less likely to choose option one. The complex, dynamic nature of wetlands requires specialists in wetland management. The FAA and sponsors normally don't possess this expertise, so wetland banking option Two (below) would be the more likely choice.

- Under option two, the 404 permit applicant can agree to purchase a specific number of credits from a bank owned by another party, provided the bank is in the same watershed as the proposed project and the permitting agency approves such a measure. Here, the banker is responsible for wetland success.

Here are two examples of the available wetland mitigation options:

An airport development project:

An airport sponsor proposing a new runway knows that constructing this facility would require filling 50 acres of wetland and that a taxiway proposed for construction 2 years later would require the filling of 10 additional wetland acres. To mitigate these impacts, the sponsor can select one of the following options and present it to the COE for approval:

- mitigate wetland impacts by traditional replacement methods that are consistent with FAA safety concerns (i.e., new wetlands should not be established in areas where they could create hazards to aviation);
- establish a 60-acre bank offsite before beginning construction of either project; or
- buy 60 credits from an acceptable, offsite wetland bank that is owned by a wetland banker who meets the criteria in item VIII.

NOTE: 1:1 impact: compensation ratios in the above examples are sometimes, but not always, acceptable.

Siting a FAA facility:

The division office planning to site a radar at a preferred location knows that construction specifications would require the filling of 2.2 acres of wetlands for foundations to support the radar's superstructure and pilings to support a 0.5-mile long access road. To mitigate these impacts, the program manager could select one of the options discussed above to offset the 2.2-acre loss.

VI. WHO IS RESPONSIBLE FOR MAINTAINING A WETLAND MITIGATION BANK?

When a 404 permittee such as an FAA program office or airport sponsor purchases credits from a bank meeting the criteria in section VIII., the banker operating that bank is solely responsible for maintaining the bank, ensuring that it is fully-functional and that it meets its intended purposes. Those purposes are clearly stated in a Memorandum of Understanding between the banker and the COE. If the COE authorizes the 404 permittee to use a designated bank, the purchase of credits from that bank fulfills the permittee's wetland mitigation obligations. The permittee has no further wetland mitigation responsibilities.

VII. WHAT IS SEQUENCING?

Sequencing is a federally-required, analytical procedure that all 404 permit applicants must complete as part of the 404 permit application process. This process follows a similar process required by the regulations implementing the National Environmental Policy Act (see Council on Environmental Quality regulations at 40 CFR section 1502.2(f)). Before using banking or any other measure to mitigate wetland impacts, the 404 permit applicant must complete the sequencing procedures described below.

1. Evaluate practicable alternatives. When proposing an action that would affect wetlands, section 2 of Executive Order 11990 and paragraph 5 of DOT's wetland order (5660.1A) require the appropriate FAA program office to demonstrate that there are no practicable alternatives that avoid the wetland. For DOT purposes, a practicable alternative is an alternative that is feasible when safety, transportation objectives, design, engineering, environment, and economics are considered. If a practicable alternative exists, the Executive Order and the DOT order require the FAA decision maker to select it. DOT's wetland order states that additional project expenses to mitigate wetland impacts or to implement an alternative do not make the mitigation or alternative impractical, since such expenses are normally considered necessary to meet national wetland policy objectives.

2. Minimize unavoidable adverse impacts. The aviation safety or aeronautical design requirements of many facilities often do not allow the responsible FAA program office or airport sponsor to build a needed facility outside a wetland. For example, to meet location and distance specifications necessary for some radars to perform their aeronautical function properly, the radars must be built at specific locations, some of which may be in wetlands. When no practicable alternative outside a wetland exists because of radars' performance requirements, the responsible FAA program office must demonstrate that the radars have been designed to minimize wetland impacts to the greatest extent practicable. An example of a design consideration that would minimize unavoidable wetland impacts is to place radar supports on pilings, instead of excavating and filling the wetland to accommodate a foundation for the supports.

3. Compensate wetland impacts that occur. After modifying the design to minimize wetland impacts, the FAA program office or airport sponsor must then compensate for any remaining adverse wetland impacts that occur due to constructing, operating, and/or maintaining the proposed facility. At this point, wetland banking is a mitigation option.

VIII. If An FAA Service Or Airport Sponsor Chooses To Use A Wetland Mitigation Bank, How Does It Decide If A Particular Bank Is Acceptable For FAA Purposes?

To meet the provisions of this strategy, the FAA program office or airport sponsor must complete the following steps before purchasing credits from a bank.

1. Ensure that the bank does not pose a threat to aviation. Wetlands and wetland banks provide excellent habitats for birds and wildlife hazardous to aviation. Although it is ecologically desirable to restore or enhance affected wildlife habitat at or near the project site to maintain ecological functions in a watershed, aircraft accident investigations have shown that hazardous wildlife attracted to wetland habitats near airports sometimes collide with aircraft causing costly damage to aircraft or injury or death to aircraft occupants. Therefore, to minimize wetland-related risks to aviation safety, FAA program offices and airport sponsors are strongly encouraged not to establish a bank or purchase credits from banks that are located within:

- 5,000 feet of a runway that serves piston-powered aircraft; or
- 10,000 feet of a runway that serves turbine-powered aircraft.

NOTE: These distances are based on a study completed by the Office of Airports' Airport Safety and Operations Division (AAS-300) that assessed aircraft approach and takeoff profiles and bird flight behavior .

FAA program offices and airport sponsors may consider using a wetland bank not meeting these distance criteria only when the bank provides special ecological functions such as:

- maintaining habitat essential to federally-listed endangered or threatened species; or
- maintaining unique wetland functions (e.g., aquifer recharge, flood control, filtration).

When these special ecological functions exist, the FAA program office or airport sponsor should consult AAS-300 at (202) 267-3389. AAS can provide recommendations for a wildlife hazard management plan to protect aviation safety.

2. *Consult the appropriate wetland resource agencies.* A 404 permit applicant must consult with the COE, the U.S. Fish and Wildlife Service, (the National Marine Fisheries Service when marine mammals or anadromous fish species are involved), the EPA, and the state agency having jurisdiction over the affected wetland. Consultation should focus on the agencies' respective concerns for wetland values and functions that the proposed project would affect and any applicable watershed or ecosystem conservation plans. Agencies should state if they will accept wetland banking as appropriate mitigation; however, as the ultimate 404 authority, the COE is responsible for authorizing the use of a particular bank and determining the number of credits required.

3. Select only COE-approved wetland banks. For permitting purposes, the COE will not allow a permittee to use a wetland bank that does not meet the success criteria stated in the Memorandum of Understanding (MOU) between the COE and the banker that establishes the wetland bank. If the 404 permittee chooses to buy credits available from a bank owned by another agency or a private entity, the responsible FAA program office must have written proof that the COE has approved the bank. This provision ensures that permittees will be dealing with a reputable wetland banker who has met federal wetland mitigation guidelines.

In most cases, the COE will base success on a wetland bank's ability to provide those wetland functions that resource agencies have determined are necessary to protect a particular ecological system or watershed. Examples of such functions are floodwater retention, sediment control, providing fishery or wildlife nursery areas, removing toxic substances, or aquifer recharge. If the permittee will purchase credits from a banker, the banker should provide written assurances that the wetland mitigation bank will be self-sustaining within 3 to 5 years, the period during which most wetlands become self-sustaining.

NOTE: For projects in Michigan and New Jersey, consult with the state wetland permitting agency. The COE and EPA have authorized these states to administer the Section 404 permitting process for wetland actions within respective state boundaries.

4. Ensure that the wetland banker has posted an appropriate environmental performance bond. When purchasing credits from a bank meeting the criteria discussed in the above items, the FAA program office or airport sponsor must also ensure that the banker has posted an environmental performance bond equal to 100% of the cost needed to build or establish a bank that meets the objectives stated in the MOU. This bond ensures that sufficient money is available for the wetland bank to meet the success criteria in item 3., if the banker goes out of business or declares bankruptcy. The banker should provide written proof of bonding to the FAA or airport sponsor.

5. Exercise fiduciary responsibilities. As a federal agency entrusted with allocating or using federal funds, the FAA program office must be financially responsible when mitigating wetland impacts or providing money to do so. Although wetland impacts must be properly mitigated, the program office must ensure that it does not overpay for credits purchased from a bank. FAA project offices or airport sponsors should negotiate with the permitting and resource agencies to ensure that the number of credits purchased fairly reflects unavoidable project-related wetland impacts. They should also negotiate to secure a fair price for those credits.

IX. How To Determine The Number Of Credits That Must Be Purchased.

Determining the number of credits that must be purchased is done on a case-by-case basis. This should be a point of negotiation among the 404 permitting agency, other resource agencies, and the 404 permittee. Experience shows that the number of credits purchased should be based on the functions lost or diminished due to project construction, the functions that the bank provides, and/or the role that surrounding upland areas play in increasing the bank's overall ecological functions. Examples of compensation : impact ratios (usually expressed in acres) are:

4:1 when credits are sold to create a buffer between a wetland and other uses;

3:1 when credits are sold to protect uplands essential to wetland survival;

2:1 when credits are sold in a bank being established; or

1:1 when credits are sold in a functioning bank;

NOTE: Actual negotiations may result in different ratios!! The above ratios are based on information from workshops and discussions with wetland bankers and wetland bank customers. They are presented only as generic guidelines.

X. How Will The FAA Or An Airport Sponsor Purchase Credits From A Wetland Mitigation Bank?

When the FAA program office or airport sponsor purchases credits from a bank, it will

do so via a legally binding purchasing contract. Contract signatories should include the 404 permitting agency (usually the COE), the appropriate resource agencies, the wetland banker, the responsible FAA program office and, when appropriate, the airport sponsor. The contract should contain the following contingencies to protect FAA funding and aviation safety.

Protection against wetland bank failure. This contingency is necessary to protect the FAA from spending additional funds on wetland mitigation after it has provided funds to purchase the permit-required number of bank credits. This contingency verifies that if a bank failure occurs, the FAA program office or the airport sponsor is not accountable for any future wetland mitigation requirements that are needed to satisfy the applicable permit. The purchasing instrument should contain the following statements:

- the purchase of a specified number of credits from the named bank <u>completely</u> satisfies the permittee's wetland mitigation responsibilities; and
- in the event of a bank failure or bankruptcy, the permittee is <u>not responsible</u> for any future financial responsibilities or other liabilities needed to mitigate wetland impacts that result from a 404 permit-authorized action.

2. Protection from wildlife hazards. Written verification that the bank is not within the 5,000 or 10,000-foot criteria discussed earlier (see section VIII) shows that the bank providing the credits should not pose hazardous conditions to aviation.

NOTE: In situations where a wetland fulfills unique functions, such as serving as recharge areas for water supply aquifers or as habitat for federally-listed endangered or threatened species, the above distance criteria may not be applicable. In such cases, contact AAS-300 for assistance.

XI. What Happens To The Bank When All Of The Bank's Credits Are Sold?

Once the COE determines that a bank is self-sustaining, and the banker has sold all of its available credits, the banker has at least three options to ensure the wetland exists in perpetuity:

- retain ownership of the wetland bank and continue to manage it;
- transfer ownership of the wetland bank to a state or a Native American tribe, if either party desires to take possession of the bank to enhance its wetland sources; or

- transfer the wetland bank to an environmental group whose primary mission is to protect wetlands and/or wildlife habitat.

Organizations having expertise in wetland management, such as state wetland or wildlife agencies or The Nature Conservancy, often seek title to banks, since their primary missions are to protect valuable wetland functions and habitats.

A NOTE REGARDING AIP-FUNDED CREDIT PURCHASES. When the FAA approves an airport development project that causes wetland impacts and requires the sponsor to mitigate those impacts, the airport sponsor may recover the costs of establishing a wetland bank or purchasing credits from a wetland bank. AIP funds can be used to reimburse the sponsor for the cost of building only that portion of its wetland bank that is used to mitigate impacts resulting from a specific, FAA-approved action. The cost of building the entire wetland bank is not AIP reimbursable, unless other FAA-approved airport developments use the remainder of the bank to mitigate wetland impacts. AIP funds may also be used to reimburse the sponsor for purchasing a specified number of credits from a bank owned by another party to mitigate project-specific wetland impacts resulting from FAA-approved airport actions.

APPENDIX N:
Liability Issues For Airport Managers Related To Wildlife Hazards

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Bird and Other Wildlife Hazards at Airports: Liability Issues for Airport Managers

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Aircraft collisions with birds (bird strikes) and other wildlife are a serious economic and safety problem. The problem has increased in the past decade because of expanding populations of many wildlife species that are hazardous to aviation (Dolbeer and Eschenfelder 2002). Cleary et al. (2004) estimated wildlife strikes (98% involving birds) cost the civil aviation industry in the USA about $500 million/year, 1990-2003. Allan and Orosz (2001) estimated that bird strikes annually cost commercial air carriers over $1.2 billion worldwide, 1999-2000. At least 194 people died and 164 aircraft were destroyed as a result of bird and other wildlife strikes with civil and military aircraft from 1988-2004 (Richardson and West 2000, Thorpe 2003, Cleary et al. 2004, Dolbeer unpublished data).

Questions are often asked about liability issues related to wildlife strikes. To help clarify this complex legal subject, I have listed below several cases involving wildlife strikes where liability issues related to airport management have been raised. This is not a complete list of liability cases and is not intended as a legal review of the cases presented. These cases are presented simply as an overview of potential liability issues that airport managers may face as a result of wildlife strikes on or near their airports.

26 February 1973. Atlanta, Georgia, USA. On departure from Dekalb-Peachtree Airport, a Learjet 24 struck a flock of brown-headed cowbirds attracted to a nearby trash-transfer station. Engine failure resulted. The aircraft crashed, killing 8 people and seriously injuring 1 person on the ground. This incident prompted the Federal Aviation Administration to develop guidelines concerning the location of solid-waste disposal facilities on or near airports. The incident generated a lengthy legal case called the “Miree” litigation in which the court finally determined that the airport manager could be held liable for failing to take the precautions possible at his level to end bird hazards (Michael 1986).

12 December 1973. Norwich, England. A Falcon Business Jet with 9 people on board struck common and black-headed gulls on takeoff from Norwich Airport. The strike caused severe damage to both engines. One minor injury resulted from the crash which destroyed the aircraft. The judge presiding over the case wrote that the

Defendants (airport operator) owed the Plaintiffs (aircraft operator and occupants) the “common duty of care”. After weighing the considerable evidence, the judge decided that the Defendants failed in their duty, and that there must be judgment for the Plaintiffs for damages. In other words, the airport operator failed to show due diligence in managing the airport’s bird hazards (Michael 1986, MacKinnon et al. 2001).

14 June 1975. Watertown, South Dakota, USA. A NA265 Sabreliner twin-engine jet ingested gulls in both engines at rotation from the Watertown Airport. The aircraft crashed, both wings were torn off, and a severe fire ensued. Three of the 6 people on board were injured and the aircraft was destroyed. The Safeco Insurance Company brought an action against the airport operator, the City of Watertown. The court maintained that the proximate cause of the crash was the failure to warn the pilot of the presence of birds. Judgment for the full value of the destroyed aircraft was entered against the airport operator (Michael 1986, MacKinnon et al. 2001).

12 November 1975. New York, New York, USA. An Oversees National Airlines DC-10-30 ingested several gulls into the #3 engine during the takeoff run at John F. Kennedy International Airport. The engine caught fire, several wheels and tires disintegrated, and the landing gear collapsed during the aborted takeoff. The aircraft then caught fire and was destroyed. Miraculously, the 139 passengers and crew (all ONA employees being ferried overseas) were able to escape the burning aircraft. There were 30 injuries but no deaths. The National Transportation Safety Board noted ineffective control of bird hazards by the airport as one of the contributing factors to the accident. A complex legal battle ensued in 1979 with ONA and the Bank of America (aircraft owner) suing the FAA, the Port Authority of New York and New Jersey, New York City (because of two landfills near the airport), and several aerospace companies in Federal or State courts. The total settlement, reached in 1985, was in excess of $15 million. Amounts paid by each party and their insurance companies are not known (Aviation Week and Space Technology 1977, U.S. Court of Appeals 1985).

7 June 1989. Genoa, Italy. A BAE 146 operated by TNT Air Cargo departing Genoa Airport at night flew through a flock of gulls at rotation. The pilot managed to return the severely damaged aircraft to the airport. Three engines were damaged. The carrier sued a number of entities for damages resulting from this bird-strike event at the airport. A decision on this case, pronounced by the Civil Court of Genoa in 2001 after 11 years of litigation, awarded the carrier $2 million in compensation. Liability was assigned as 50% to the Ministry of Transport, 30% to the private company operating the airport, and 20% to the Port Authority (Battistoni 2003).

11 January 1990. Nashville, Tennessee, USA. A Hawker-Siddeley 125 jet with 4 people on board hit a deer on takeoff from John Tune Airport. The impact tore one of the engines loose from the plane. The experienced pilot was able to get airborne and fly to nearby Nashville International Airport where an emergency landing was made. Ren Corporation (owner of jet) sued the Metropolitan Nashville Airport Authority and John Tune Aviation Corporation for damages to cover the cost of replacing the $1.4 million plane and chartering another plane until a replacement plane was acquired (Nashville Tennessean 1990). The lawsuit was won in trial court, but lost in the Tennessee Court of Appeals (Gilbert 2004). The ruling was based on the Tennessee Governmental Tort Liability Act (TGTLA) capping government liability for property damage to $50,000 (Neill 2003).

20 January 1995. Paris, France. A Dassault Falcon 20 business jet struck lapwings during takeoff from Le Bourget Airport. The pilot was unable to control the jet after the ingested birds destroyed the left engine. The aircraft crashed, killing all 10 people aboard. A subsequent inquiry found that airport staff failed to perform routine bird-scaring operations prior to the accident. In 1998, French authorities laid charges of involuntary manslaughter against the Paris Airport Authority and 3 former officers for their roles in the accident. The airport authority was accused of “negligently failing to follow normal security procedures.” The disposition of the case is not known at this time (MacKinnon et al. 2001).

3 June 1995. New York, New York, USA. An Air France Concorde, at about 10 feet AGL while landing at John F. Kennedy International Airport, ingested 1 or 2 Canada geese into the #3 engine. The engine suffered an uncontained failure. Shrapnel from the #3 engine destroyed the #4 engine and cut several hydraulic lines and control cables. The pilot was able to land the plane safely, but the runway was closed for several hours. Damage to the Concorde was estimated at over $7 million. The French Aviation Authority sued the Port Authority of New York and New Jersey and eventually settled out of court for $5.3 million (MacKinnon et al. 2001).

22 September 1995. Elmendorf Air Force Base, Alaska, USA. A U.S. Air Force Airborne Warning and Control System (AWACS) aircraft (modified Boeing 707) crashed, killing all 24 on board, after ingesting 4 Canada geese into the #1 and #2 engines during takeoff from Elmendorf Air Force Base. Investigators found the “worst possible combination of operational conditions” including infrequent and inadequate wildlife patrols. Furthermore, the senior tower controller was reported by witnesses as saying he "observed geese lift off and turn directly into the path of the aircraft." When interviewed, the senior controller and another controller on duty at the time of the accident (both of whom "had an excellent view of the runway”) invoked their right to remain silent. The accident investigator concluded that controllers "had a duty to warn the flight crew and that failure to do so was a contributing factor to the accident" (Flight Safety Foundation 1996). One outcome of the investigation was that the people in the top 3 leadership positions at the air base were reassigned.

13 November 1996. Pula International Airport, Pula, Croatia. A Croatia Airlines B-737-200 ingested a gull into the #1 engine during the takeoff run at 1511 hours, causing an “insidious explosion” from the engine. The pilot was able to abort the takeoff, but the engine had to be replaced and the plane was out of service for 2 days. Croatia Airline’s insurer paid the airline for the damaged engine but then presented a bill to the airport for the cost of repairs. The airport refused to pay, claiming that the airport had fulfilled all the conditions for the protection of aircraft from wildlife (including a runway sweep at 0430 hours) and that they had a permanent NOTAM to warn air carriers of concentrations of birds in the vicinity of the runway. The insurance company sued the Airport Authority in the Municipal Court of Pula. The Municipal Court dismissed the lawsuit, but on appeal, the County Court of Pula ruled in favor of the insurance company. An appeal of this decision by the airport was unsuccessful (18 April 2000), and the airport had to reimburse the insurance company for cost of engine repairs. The court noted that that the airport acknowledged that a problem existed by having a permanent NOTAM regarding bird hazards, and yet failed to undertake all measures at its disposal to alleviate the hazard (Pula County Court 2000).

22 March 1998. Marseille Provence Airport, France. An Air France A-320 encountered a flock of about 20 gulls during the takeoff run, ingesting several birds into the #2 engine which was destroyed. The pilot executed a high-speed aborted takeoff. The gull strike was directly attributed to a dead hedgehog on the runway which the gulls were feeding on when the mishap occurred. The air carrier sued the French government for negligence in operating the airfield and in January 2005 was awarded $4 million USD (Agence France Presse 2005). The hedgehog had likely been struck by an earlier flight, but Airport Operations personnel had failed to remove the carcass.

Conclusions:

Based on the cases presented above and legal or insurance reviews by Michael (1986), Wilkinson (1998), Robinson (2000), and Matijaca (2001), it is apparent that airport operators must exercise "due diligence" in managing wildlife hazards to avoid potentially serious liability issues.

The exercise of "due diligence" to manage wildlife hazards involves (in the USA) the assessment of wildlife hazards at the airport and, if needed based on the assessment, the implementation of a wildlife hazard management plan (FAA regulations in CFR 14 Part 139.337). An important component of the wildlife hazard management plan is the prevention of habitats and land uses on or in the vicinity of the airport that are attractive to hazardous wildlife. Wildlife hazard management at airports is a complex, public-sensitive, endeavor involving many species of wildlife and their habitats governed by various federal and state regulations. Airports need to employ professional biologists trained in wildlife damage control to assist in the development, implementation, and evaluation of wildlife hazard management plans. Such professionally developed and implemented management plans will minimize the likelihood of catastrophic or major-damage wildlife strikes on an airport and provide crucial support during litigation in the aftermath of any significant strike event that might occur. Cleary and Dolbeer (1999) provide detailed information on the development of these management plans as well as on FAA regulations and guidelines regarding wildlife hazards to aviation.

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References cited

Agence France Presse. 2005. A dead hedgehog and a flock of seagulls cost France 3 million euros after runway mishap. Marseilles, France. 1 February 2005.

Allan, J. R., and A. P. Orosz. 2001. The costs of birdstrikes to commercial aviation. Pages 218-226 in Bird Strike 2001, Proceedings of the Bird Strike Committee-USA/Canada meeting. Calgary, Alberta, Canada: Transport Canada, Ottawa, Ontario Canada.

Aviation Week and Space Technology. 1997. Recommendations made in ONA crash.

August 15, Page 61.

Battistoni, V. 2003. Bird strikes in courts: the Genoa case. Pages 169-174 in Proceedings of the 26th International Bird Strike Committee meeting (Volume 1). Warsaw, Poland.

Cleary, E. C., and R. A. Dolbeer. 1999. Wildlife hazard management at airports, a manual for airport personnel. U.S. Department of Transportation, Federal Aviation Administration, Office of Airport Safety and Standards, Washington, DC USA 248 pages (http://wildlife-mitigation.tc.faa.gov/).

Cleary, E. C., R. A. Dolbeer, and S. E. Wright. 2004. Wildlife strikes to civil aircraft in the United States, 1990-2003. U.S. Department of Transportation, Federal Aviation Administration, Serial Report No. 10, DOT/FAA/AS/00-6(AAS-310). Washington DC USA. 55 pages (http://wildlife-mitigation.tc.faa.gov/).

Dolbeer, R. A., and P. Eschenfelder. 2002. Population increases of large birds, airworthiness standards, and high-speed flight: a precarious combination. Pages 273-281 in Proceedings of the 55th International Air Safety Seminar, Dublin, Ireland (Copyright Flight Safety Foundation, Alexandria, Virginia USA).

Flight Safety Foundation. 1996. Military Boeing 707 strikes birds after liftoff; damages to engines no. 1 and no. 2 results in loss of power and impact with terrain. Accident Prevention. Volume. 53, Number 11.

Gilbert, Harris A. 2004. Attorney representing REN Corp. Personal communication.23 January.

MacKinnon, B., R. Sowden, and S. Dudley (Editors). 2001. Sharing the skies: an aviation guide to the management of wildlife hazards. Transport Canada, Aviation Publishing Division, Tower C, 330 Sparks Street, Ottawa, Ontario, K1A 0N8 Canada. 316 pages.

Matijaca, A. 2001. Damage liability and compensation in case of bird strike. Pages 89-100 in Bird Strike 2001. Proceedings of the Bird Strike Committee-USA/Canada meeting, Calgary, Alberta. Transport Canada, Ottawa, Ontario Canada.

Michael, R. A. 1986. Keep your eye on the birdie: aircraft engine bird ingestion. Journal of Air Law and Commerce. Space Law Issue. Summer 1986, Number 4:1007-1035.

Nashville Tennessean. 1990. Dialysis firm files suit after plane strikes deer. By Kirk Loggins, January.

Neill, R. 2003. Municipal and personal liability under the Tennessee Government Tort Liability Act. Municipal Technical Advisory Service (MTSA). [online] (www.mtas.utk.edu/knowledgebase.nsf/0/c0fead9bb6aca88685256d3600653d26/$FILE/Governmental%20Tort%20Liability%20Act.pdf); accessed 23 January 2004.

Pula County Court. 2000. Liability of Pula Airport for the damages from bird strikes. County Court, Pula, Republic of Croatia, case Gž-2141/00.

Richardson, W. J., and T. West. 2000. Serious birdstrike accidents to military aircraft:

updated list and summary. Pages 67-98 in Proceedings of 25th International Bird Strike Committee meeting. Amsterdam, The Netherlands.

Robinson, M. 2000. The duty of care—failure to maintain an effective "wildlife control programme" might result in significant legal liability consequences. Aon Group Limited, Aviation Reinsurance Department, 8 Devonshire Square, EC2M 4PL, London, UK (mike.robinson@aon.co.uk).

Thorpe, J. 2003. Fatalities and destroyed aircraft due to bird strikes, 1912-2002. Pages 85-113 in Proceedings of the 26th International Bird Strike Committee meeting (Volume 1). Warsaw, Poland.

U.S. Court of Appeals for the Second Circuit. 1985. Overseas National Airways, Inc. Plaintiff, v. United States of America, Defendant-Third-party Plaintiff-Appellant, Port Authority of New York and New Jersey, Third–party Defendant-Appellant, and The City of New York, Third-Party Defendant-Appellee. Nos. 84-6232, 84-6254 (Aug. term, 1984). Decided 27 June 1985.

Wilkinson, C. 1998. Now aviation insurers must watch the birdie. Insurance Day. Lloyd's of London Press Ltd, London, UK. 5 February. 2 pages.

APPENDIX O:
Summary of Studies on Vegetation Management for North American Airfields

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Summary Of Studies On Vegetation Management For North American Airfields

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Habitat management is a critical element in any wildlife hazard management program at an airport. Non-woody or herbaceous vegetation accounts for the majority of wildlife habitat at most airports. If this vegetation is not managed, the site will often become overgrown and attractive to wildlife that are hazardous to aircraft (Barras et al. 2000, Cleary et al. 2003).

Vegetation management on many USA airports consists of mowing the vegetation to some set height. The Federal Aviation Administration has not specified the height that vegetation is to be maintained away from the movement area. One method often suggested for reducing bird numbers on airports is to maintain vegetation at 6-10 inches, as opposed to standard mowing practices that maintain vegetation at 2-4 inches (Transport Canada 1994, US Department of Agriculture 1998, Civil Aviation Authority 2002). Vegetation 6-10 inches high is thought to interfere with visibility and ground movements of flocking birds such as European starlings and gulls (Solman 1966, Blokpoel 1976). However, the scientific support for this height is based on studies done in Great Britain (Brough 1971, Mead and Carter 1973, and Brough and Bridgman 1980), in which bird species of concern in North America were not present. Many other sources recommend tall vegetation but do not present data to support the recommended height (Wright 1968, Creswell 1988, Blokpoel 1976, Burger 1983, Solman 1970, 1973, 1976, Transport Canada 1994, Dekker and van der Zee 1996, US Department of Agriculture 1998). In Great Britain, long-grass management involves a rigorous regime of mowing within a 2-inch window along with thatch and weed removal and the use of fertilizers to maintain an erect, dense stand of grass (Civil Aviation Authority 2002). North American airfields generally do not have similar vegetation management plans. Therefore, observations drawn from long-grass management in Great Britain must be applied cautiously in North America.

Previous studies on tall vegetation management at airports in the United States have produced conflicting results (Buckley and McCarthy 1994, Seamans et al. 1999, Barras et al. 2000). Further, other published views that may not be scientifically defensible (Barras and Seamans 2002) have indicated that “tall vegetation” should not be on airfields (van Tets 1969, Solman 1970). Blokpoel (1976) indicated that vegetation height management should be dependent on the bird species using the airfield.

Mowing has been shown to at least temporarily reduce small mammal populations (Wilkins and Schmidly 1979, Lemen and Clausen 1984, Grimm and Yahner 1988, Edge et al. 1995). Fewer small mammals may reduce the attractiveness of the area to birds of prey (e.g. red-tailed hawks, great-horned owls) and predatory mammals (e.g. coyotes) that pose hazards to aircraft (Phelan and Robertson 1977, Baker and Brooks 1981a, Dolbeer et al. 2000). Should a small mammal population remain after mowing, predators will be attracted to the area because of improved opportunity to capture prey due to the removal of protective overhead vegetation (Wakeley 1978, Baker and Brooks 1981b, Bechard 1982, Preston 1990, Sheffield et al. 2001, Fitzpatrick 2003). It is also likely that small mammals in unmowed areas will exploit adjacent mowed areas (Cleary et al. 2003) due to a lack of competition in mowed areas. Therefore, despite the decrease in small mammals caused by mowing, the number or frequency of potential predators in this area could be higher because of the potential for efficient foraging along the edge of the two areas. To avoid this conflict, airports should mow all areas within their control. Additional small mammal control (e. g. using a rodenticide) may be necessary if mowing does not reduce the population to a point that the area becomes unattractive to predators.

Vegetation density, structure, species composition and size of grassy areas have been shown to influence bird use of grasslands (Mead and Carter 1973, Frawley and Best 1991, Delisle and Savidge 1997, Norment et al. 1999, Washburn et al. 2000, Johnson and Igl 2001). Ideally, vegetation found on airports should have low attraction to birds, small mammals and insects; have hardy growth and good survival; and provide good ground coverage without being a fire hazard (Austin-Smith and Lewis 1969). No published studies have been conducted on field evaluations that provide information on vegetation that meets these requirements. Initial pen trial results at the USDA National Wildlife Research Center (NWRC)/Ohio Field Station (OFS) using tall fescue containing the fungal endophyte (*Neotyphodium coenophialum)* indicate that Canada geese do not prefer to feed on the grass (Washburn and Seamans 2004).

Research at the NWRC/OFS has shown that vegetation height alone does not reduce bird use of grassland areas (Seamans et al. 2005). Species-specific responses may be expected. For example, brown-headed cowbirds and American robins prefer short (<6 in) vegetation, starlings do not differentiate between short (<6 in) and tall (>6 in) vegetation and eastern meadowlarks prefer tall (>6 in) vegetation. Airport managers need to work with airport wildlife biologists to determine what species of concern in regards to aircraft safety are in their area and what the habitat needs are for those species.

Response of vegetation to mowing must also be considered. Some species of vegetation will not live if mowers are set below 4 inches. Drought conditions may also necessitate a change in timing of mowing or height of mowers in order to avoid causing vegetation die offs.

Considering bird, mammal and vegetation limitations, mowing at least monthly at a target of 5 - 8 inches may work in many airport environments as part of a wildlife hazard management program. Most grasses used on airfields in non-arid habitats should be able to survive this mowing height. In addition, vegetation will be short enough to enable observers to see larger birds yet long enough to prevent birds that prefer short vegetation from using the area. However, starlings and meadowlarks will use both tall and short vegetation. Density and species of vegetation may limit both species use but these specifications have not been determined. Any area that has sparse vegetation will allow birds to move through or land. Mowing at 5 - 8 inches should also reduce small mammal abundance.

A dense, monotypic stand of vegetation that wildlife do not prefer for food or cover would be ideal airfield vegetation. Researchers will continue to work on this issue to find species that meet airport demands in the various regions of the United States.

References

Austin-Smith, P. J., and H. F. Lewis. 1969. Alternative vegetative ground cover. Pp. 153—160 *in* Proceedings of the World Conference on Bird Hazards to Aircraft.

Baker, J. A., and R. J Brooks. 1981*a*. Raptor and vole populations at an airport. Journal of Wildlife Management 45:390—396.

Baker, J. A., and R. J Brooks. 1981*b*. Distribution patterns of raptors in relation to density of meadow voles. Condor 83:42—47.

Barras, S. C., R. A. Dolbeer, R. B. Chipman, G. E. Bernhardt, and M. S. Carrara. 2000. Bird and small mammal use of mowed and unmowed vegetation at John F. Kennedy International Airport, 1998-1999. Proceedings of the Vertebrate Pest Conference 19:31—36.

Barras, S. C. and T. W. Seamans. 2002. Habitat management approaches for reducing wildlife use of airfields. Proceedings of the Vertebrate Pest Conference 20:309—315.

Bechard, M. J. 1982. Effect of vegetative cover on foraging site selection by Swainson's hawk. Condor 84:153—159.

Blokpoel, H. 1976. Bird hazards to aircraft. Clarke, Irwin and Company and Canadian Wildlife Service, Ottawa, Canada.

Brough, T. E. 1971. Experimental use of long-grass in the U.K. Bird Strike Committee Europe 6:unpaged.

Brough, T. E., and C. J. Bridgman. 1980. An evaluation of long-grass as a bird deterrent on British airfields. Journal of Applied Ecology 17:243—253.

Buckley, P. A., and M. G. McCarthy. 1994. Insects, vegetation, and the control of laughing gulls (*Larus atricilla*) at Kennedy International Airport, New York City. Journal of Applied Ecology 31:291—302.

Burger, J. 1983. Bird control at airports. Environmental Conservation 10:115—124.

Civil Aviation Authority. 2002 Aerodrome Bird Control. CAP 680. Aerodrome Standards Department, Safety Regulation Group. Gatwick Airport South, West Sussex, UK.

Cleary, E. C., R. A. Dolbeer, and P. R. Bastida. 2003. The Mexico City International Airport project: bird and mammal concerns at the existing airport and Ex-vaso de Texcoco. Supplemental report Number 5. Special report for US Department of Transportation, Federal Aviation Administration, Washington, DC.

Creswell, P. D. 1988. Bird species, populations, and activities at Christchurch International Airport, New Zealand, between 1986 and 1988: implications for a preventative bird strike program. New Zealand Natural Sciences 15:61—70.

Dekker, A., and F. F. van der Zee. 1996. Birds and grassland on airports. Bird Strike Committee Europe 23:291—305.

Delisle, J. M, and J. A. Savidge. 1997. Avian use and vegetation characteristics of conservation reserve program fields. Journal of Wildlife Management 61:318—325.

Dolbeer, R. A., S. E. Wright, and E. C. Cleary. 2000. Ranking the hazard level of wildlife species to aviation. Wildlife Society Bulletin 28:372—378.

Edge, W. D., J. O. Wolff, and R. L. Carey. 1995. Density-dependent responses of gray-tailed voles to mowing. Journal of Wildlife Management 59:245—251.

Fitzpatrick, K. J. 2003. Effects of mowing on the selection of raptor foraging habitat. Dissertation, University of Maryland, College Park, Maryland, USA.

Frawley, B. J., and L. B. Best. 1991. Effects of mowing on breeding bird abundance and species composition in alfalfa fields. Wildlife Society Bulletin 19:135—142.

Grimm, J. W., and R. H. Yahner. 1988. Small mammal response to roadside habitat management in south central Minnesota. Journal of the Minnesota Academy of Science 53:16—21.

Johnson, D. H., and L. D. Igl. 2001. Area requirements of grassland birds: a regional perspective. Auk 118:24—34.

Lemen, C. A., and M. K. Clausen. 1984. The effect of mowing on the rodent community of a native tall grass prairie in eastern Nebraska. Prairie Naturalist 16:5—10.

Mead, H., and A. W. Carter. 1973. The management of long grass as a bird repellent on airfields. Journal of British Grassland Society 28:219—221.

Norment, C. J., C. D. Ardizzone, and K. Hartman. 1999. Habitat relations and breeding biology of grassland birds in New York. Studies in Avian Biology No. 19:112—121.

Phelan, F. S., and R. J. Robertson. 1977. Predatory responses of a raptor guild to changes in prey density. Canadian Journal of Zoology 56:2565—2572.

Preston, C. R. 1990. Distribution of raptor foraging in relation to prey biomass and habitat structure. Condor 92:107—112.

Seamans, T. W., R. A. Dolbeer, M. S. Carrara, and R. B. Chipman. 1999. Does tall grass reduce bird numbers on airports?: Results of pen test with Canada geese and field trials at two airports, 1998. Proceedings Joint Meeting of Bird Strike Committee Canada and Bird Strike Committee USA, Vancouver, British Columbia 161—170.

Seamans, T. W., G. E. Bernhardt, B. F. Blackwell, S. C. Barras, and J. D. Cepek. 2005. Comparison of two vegetation height management practices for wildlife control. American Midland Naturalist: (In Review)

Sheffield, L. M., J. R. Crait, W. D. Edge, and G. Wang. 2001. Response of American kestrels and gray-tailed voles to vegetation height and supplemental perches.

Canadian Journal of Zoology 79:380—385.

Solman, V.E.F. 1966. Ecological control of bird hazard to aircraft. Proceedings of the Bird Control Seminar 3:38—56.

Solman, V. E. F. 1970. Airport design and management to reduce bird problems. Proceedings First World Conference on Bird Hazards to Aircraft, National Research Council of Canada 1:143—147.

Solman, V. E. F. 1973. Birds and aircraft. Biological Conservation 5:79—86.

Solman, V. E. F. 1976. Aircraft and birds. Proceedings of the Seventh Bird Control Seminar, Bowling Green State University, Bowling Green, Ohio pp.83—88.

Transport Canada. 1994. Wildlife control procedures manual. Environmental and Support Services, Airports Group. TP11500E. Ottawa, Canada.

U. S. Department of Agriculture. 1998. Managing wildlife hazards at airports. Animal and Plant Health Inspection Service, Wildlife Services, Washington, D. C.

van Tets, G. F. 1969. Quantitative and qualitative changes in habitat and avifauna at Sydney airport. CSIRO Wildlife Research 14:117—128.

Wakeley, J. S. 1978. Factors affecting the use of hunting sites by ferruginous hawks. Condor 80:316—326.

Washburn, B. E., T. G. Barnes, and J. D. Sole. 2000. Improving northern bobwhite habitat by converting tall fescue fields to native warm season grasses. Wildlife Society Bulletin 28:97—104.

Washburn, B. E. and T. W. Seamans. 2004. Management of vegetation to reduce wildlife hazards at airports. Proceedings FAA Worldwide Airport Technology Transfer Conference. Atlantic City New Jersey.

Wilkins, K. T., and D. J. Schmidly. 1979. The effects of mowing highway rights-of-way on small mammals. Proceedings Second Symposium on Environmental Concerns in Rights-of-way Management, Ann Arbor, Michigan.

Wright, E. N. 1968. Modification of the habitat as a means of bird control. Pp. 97—116 *in*: R. K. Murton and E. N. Wright (editors). The problem of birds as pests. Academic Press, London.

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Appendix P:
Title 14, Code of Federal Regulations, Part 139.337

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Title 14, Code of Federal Regulations, part 139.337

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

(b) In a manner authorized by the Administrator, each certificate holder must ensure that a wildlife hazard assessment is conducted when any of the following events occurs on or near the airport

(b) (1) An air carrier aircraft experiences multiple wildlife strikes:

(b) (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;

(b) (3) An air carrier aircraft experiences an engine ingestion of wildlife; or

(b) (4) Wildlife of a size, or in numbers, capable of causing an event described in paragraph (b)(1), (2), or (3) of this section is observed to have access to any airport flight pattern or aircraft movement area.

(c) The wildlife hazard assessment required in paragraph (b) of this section must be conducted by a wildlife damage management biologist who has professional training and/or experience in wildlife hazard management at airports or an individual working under direct supervision of such an individual. The wildlife hazard assessment must contain at least the following:

(c) (l) An analysis of the events or circumstances that prompted the assessment.

c) (2) Identification of the wildlife species observed and their numbers, locations, local movements, and daily and seasonal occurrences.

(c) (3) Identification and location of features on and near the airport that attract wildlife.

(c) (4) A description of wildlife hazards to air carrier operations.

(c) (5) Recommended actions for reducing identified wildlife hazards to air carrier operations.

(d) The wildlife hazard assessment required under paragraph (b) of this section must be submitted to the Administrator for approval and determination of the need for a wildlife hazard management plan. In reaching this determination, the Administrator will consider—

(d) (1) The wildlife hazard assessment;

(d) (2) Actions recommended in the wildlife hazard assessment to reduce wildlife hazards;

(d) (3) The aeronautical activity at the airport, including the frequency and size of air carrier aircraft;

(d) (4) The views of the certificate holder;

(d) (5) The views of the airport users; and

(d) (6) Any other known factors relating to the wildlife hazard of which the Administrator is aware.

(e) When the Administrator determines that a wildlife hazard management plan is needed, the certificate holder must formulate and implement a plan using the wildlife hazard assessment as a basis. The plan must—

(e) (1) Provide measures to alleviate or eliminate wildlife hazards to air carrier operations;

(e) (2) Be submitted to, and approved by, the Administrator prior to implementation; and

(e) (3) As authorized by the Administrator, become a part of the Airport Certification Manual.

(f) The plan must include at least the following:

(f) (1) A list of the individuals having authority and responsibility for implementing each aspect of the plan.

(f) (2) A list prioritizing the following actions identified in the wildlife hazard assessment and target dates for their initiation and completion:

(f) (2) (i) Wildlife population management;

(f) (2) (ii) Habitat modification; and

(f) (2) (iii) Land use changes.

(f) (3) Requirements for and, where applicable, copies of local, State, and Federal wildlife control permits.

(f) (4) Identification of resources that the certificate holder will provide to implement the plan.

(f) (5) Procedures to be followed during air carrier operations that at a minimum includes—

(f) (5) (i) Designation of personnel responsible for implementing the procedures;

(f) (5) (ii) Provisions to conduct physical inspections of the aircraft movement areas and other areas critical to successfully manage known wildlife hazards before air carrier operations begin;

(f) (5) (iii) Wildlife hazard control measures; and

(f) (5) (iv) Ways to communicate effectively between personnel conducting wildlife control or observing wildlife hazards and the air traffic control tower.

(f) (6) Procedures to review and evaluate the wildlife hazard management plan annually or following an event described in paragraphs (b)(1), (2), and (3) of this section, including:

(f) (6) (i) The plan's effectiveness in dealing with known wildlife hazards on and in the airport's vicinity and

(f) (6) (ii) Aspects of the wildlife hazards described in the wildlife hazard assessment that should be reevaluated.

(f) (7) A training program conducted by a qualified wildlife damage management biologist to provide airport personnel with the knowledge and skills needed to successfully carry out the wildlife hazard management plan required by paragraph (d) of this section.

(g) FAA Advisory Circulars contain methods and procedures for wildlife hazard management at airports that are acceptable to the Administrator.

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Coastal Barrens Buckmoth

Hemileuca maia

Photo credits: *Jim Vargo*

Scientific Name *Hemileuca maia ssp. 5*

Family Name Saturniidae
Giant Silkworm and Royal Moths

Did you know?
The name "buck moth" was given to this moth by American outdoorsmen who associated its flight season in October with deer hunting season (Cryan 1985).

Summary

Protection Species of Special Concern in New York State, not listed federally.

This level of state protection means: A native species at risk of becoming Threatened; does not qualify as Endangered or Threatened, but have been determined to require some measure of protection or attention to ensure that the species does not become threatened. NYSDEC may regulate the takin

Rarity G5T3, S2

A global rarity rank of G5T3 means: Vulnerable globally - The subspecies/variety is at moderate risk of extinction due to rarity or other factors; typically 80 or fewer populations or locations in the world, few individuals, restricted range, few remaining acres (or miles of stream), and/or recent and widespread declines. (The species as a whole is common globally.)
A state rarity rank of S2 means: Typically 6 to 20 occurrences, few remaining individuals, acres, or miles of stream, or factors demonstrably make it very vulnerable in New York State.

Conservation Status in New York

Within New York State, 18 populations of the Coastal Barrens Buckmoth are known to occur on Long Island. The subspecies is probably restricted to southeastern Massachusetts, Rhode Island, and Long Island, New York (NatureServe 2010).

Short-term Trends

The presence of the Coastal Barrens Buckmoth over multiple years at most of the 18 documented populations in New York State indicates that the population is stable, viable, and reproducing.

Long-term Trends

The long-term trend for the Coastal Barrens Buckmoth in New York State is unknown (New York State Department of Environmental Conservation 2005), but on Long Island four populations are known to have become extirpated due to habitat loss from development, indicating the moth has probably declined from historical numbers.

Conservation and Management

Threats

Threats include destruction of habitat due to development and fire suppression, which may become a problem after several decades (NatureServe 2010). Insecticide spraying might also be a threat. In addition, the Coastal Barrens Buckmoth was assessed to be moderately vulnerable to climate change, meaning that its abundance and/or range extent within its current geographical area in New York State is likely to decrease by 2050 as a result of climate change. Factors that may increase its vulnerability to climate change include its physiological thermal niche, physiological hydrological niche, physical habitat, and diet (Schlesinger et al. 2011).

Conservation Strategies and Management Practices

Maintaining habitat is the main management need. Periodic controlled burns or mechanical removal of vegetation are needed to maintain most of the natural communities that the Coastal Barrens Buckmoth inhabits. It is good practice to not burn entire habitats at once. Habitats should be burned in patches, always with some unburned areas left as refugia for species (Wagner et al. 2003). However, it is possible that the Coastal Barrens Buckmoth maintains a reserve of diapausing (dormant) pupae in the soil, enabling populations to survive fires (NatureServe 2010).

Research Needs

Additional inventory and monitoring is needed, particularly at the few unchecked potential sites, mostly scattered barrens remnants on Long Island. The Coastal Barrens Buckmoth flies during the day and can be captured by netting with butterfly nets. In addition, males can be attracted to bait from caged females, larvae can be easily observed on scrub oak (Quercus ilicifolia) and other shrubby vegetation, and eggs can be observed on twigs of scrub oak and other shrubby vegetation from the fall until the spring.

Habitat

The Coastal Barrens Buckmoth is restricted to pitch pine-scrub oak barrens, including the Long Island Dwarf Pine Plains, on deep dry sands. It is also found on portions of the Nantucket heathlands with a lot of scrub oak. It is tolerant of either sparse canopy or no canopy (NatureServe 2010).

Associated Ecological Communities

Dwarf Pine Plains
A woodland community dominated by dwarf individuals of pitch pine and scrub oak that occurs on nearly level outwash sand and gravel plains in eastern Long Island. The soils are infertile, coarse textured sands that are excessively well-drained.

Pitch Pine-oak-heath Woodland
A pine barrens community that occurs on well-drained, infertile, sandy soils. The structure of this community is intermediate between a shrub-savanna and a woodland. Pitch pine and white oak are the most abundant trees.

Pitch Pine-scrub Oak Barrens
A shrub-savanna community that occurs on well-drained, sandy soils that have developed on sand dunes, glacial till, and outwash plains.

Identification Comments

Identifying Characteristics

Buckmoths of the species Hemileuca maia in general have a wingspan of 50-75 mm, and black forewings and hind wings, with white semi-translucent bands in the middle. The reniform spot on the forewing has a black border, and it touches the black basal patch. Males have a red-tipped abdomen, and females have a black-tipped abdomen (Covell 1984). The Coastal Barrens Buckmoth subspecies is distinguished by its small size, narrow habitat restriction, and especially by the extensive bright yellow pattern on late-instar larvae that includes a well-defined lateral band in almost all individuals on Long Island. Larvae are otherwise usually black and have branching spines along their back that can sting (Tuskes et al. 1996). The adults are somewhat thinly scaled (NatureServe 2010).

Behavior

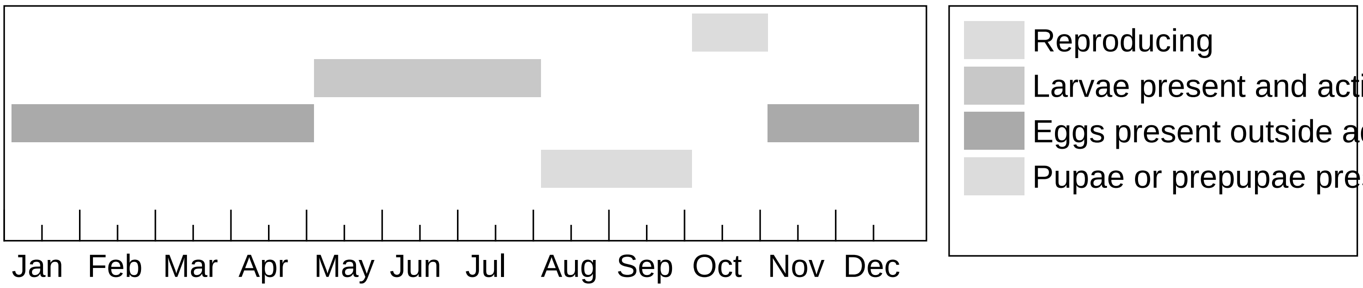
Contrary to most moths that fly at night, Coastal Barrens Buckmoths fly during the day. On Long Island, they fly on sunny days in October. The moths emerge in the morning, with males emerging earlier than females. Mating usually takes place in the early afternoon, and females oviposit in the late afternoon. Females lay eggs in clustered rings, usually around twigs of scrub oak (Quercus ilicifolia), or sometimes other species of shrubby oaks. Females lay 1-3 egg ring clusters, with each cluster containing 50-250 eggs (Tuskes et al. 1996). The eggs overwinter and are coated with a waxy substance to prevent them from desiccating. In addition, the larvae inside are protected from the cold by a kind of natural antifreeze (Cryan 1985). The eggs hatch in the spring, and early-instar larvae feed together in groups in June and July. The small black larvae have many spines that inflict a painful sting when touched, which provides them protection from many predators but does not protect them from some parasites. By July, late-instar larvae scatter and become more solitary. At this stage, they may be found on plants other than oak. In late July or early August, larvae go a few cm below the soil surface, or between the soil surface and the leaf litter, where they transform into pupae and lie dormant until emerging as adult moths in the fall (Cryan 1985; Tuskes et al. 1996; Nelson 2007).

Diet

The larva of the Coastal Barrens Buckmoth is virtually restricted to scrub oak (Quercus ilicifolia) as its primary foodplant. A single report of oviposition on wild black cherry (Prunus serotina) is known. Like other subspecies of Hemileuca maia, larvae will readily eat most other oaks, willows, aspens, and P. serotina. In nature, older larvae do disperse and use willows, P. serotina, and other oaks occasionally if they encounter them. Young larvae eat new spring leaves, and older larvae eat mature leaves. Adult moths do not feed (NatureServe 2010).

The Best Time to See

On Long Island, New York, Coastal Barrens Buckmoth larvae can be seen from May until July, and adults can be seen during their flight period in October. In addition, overwintering eggs are visible on vegetation from late fall until early spring.



The time of year you would expect to find Coastal Barrens Buckmoth in New York.

Similar Species

Bogbean Buckmoth(Hemileuca sp 1): H. maia ssp. 5 is distinguished by the yellow pattern on late-instar larvae, and by its geographic range.

Inland Barrens Buckmoth(Hemileuca maia maia): H. maia ssp. 5 is distinguished by the yellow pattern on late-instar larvae, and by its geographic range.

Conservation Comments

The name Hemileuca maia subspecies 5 is used here for a cluster of distinctive populations on Long Island, New York, and the Cape Cod region, which differ from all other maia populations north of Florida by a combination of characters including larval coloration, adult appearance, and high restriction to open pine canopy sandy scrub oak barrens. The general literature recognizes only H. maia maia and H. maia peigleri, and the name H. maia maia is applied to the entire species outside of Texas. Here, the distinctive northern Coastal Barrens Buckmoth is also recognized as subspecies 5, and technically it probably is typical H. maia maia. Hemileuca maia maia is used for the rest of the entire eastern US oak-feeding buckmoth species, except for subspecies peigleri from central Texas.

Taxonomy

Kingdom Animalia
└─ **Phylum** Mandibulates (Mandibulata)
  └─ **Class** Insects (Insecta)
    └─ **Order** Butterflies, Skippers, and Moths (Lepidoptera)
      └─ **Family** Saturniidae (Giant Silkworm and Royal Moths)

Additional Resources

Links

Moth Photographers Group
http://mothphotographersgroup.msstate.edu/species.php?hodges=7730
Butterflies and Moths of North America
http://www.butterfliesandmoths.org/species/Hemileuca-maia
NatureServe Explorer
http://natureserve.org/explorer/servlet/NatureServe?searchName=HEMILEUCA+MAIA+SSP+5
Google Images
http://images.google.com/images?q=HEMILEUCA+MAIA+SSP+5
BugGuide
http://bugguide.net/node/view/471

References

Covell, Charles V. 1984. A field guide to the moths of eastern North America. Houghton Mifflin Company, Boston.

Cryan, J.F. and R. Dirig. 1975. The moths of autumn. Unpublished article printed by Pine Bush Historical Preservation Project, Inc. 9 pp.

Cryan, John. 1985. Retreat in the barrens. Defenders. 60(1): 18-29.

Keys, Jr.,J.; Carpenter, C.; Hooks, S.; Koenig, F.; McNab, W.H.; Russell, W.;Smith, M.L. 1995. Ecological units of the eastern United States - first approximation (cd-rom), Atlanta, GA: U.S. Department of Agriculture, Forest Service. GIS coverage in ARCINFO format, selected imagery, and map unit tables.

NatureServe. 2005. NatureServe Central Databases. Arlington, Virginia. USA

NatureServe. 2010. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Available http://www.natureserve.org/explorer. (Data last updated August 2010)

Nelson, M.W. 2007. Barrens Buckmoth (Hemileuca maia). Natural Heritage & Endangered Species Program Fact Sheet.

New York State Department of Environmental Conservation. 2005. Comprehensive Wildlife Conservation Strategy Planning Database. New York State Department of Environmental Conservation. Albany, NY.

North American Moth Photographers Group at the Mississippi Entomological Museum. No date. Mississippi State University, Mississippi.

http://mothphotographersgroup.msstate.edu/MainMenu.shtml

Opler, Paul A., Kelly Lotts, and Thomas Naberhaus, coordinators. 2010. Butterflies and Moths of North America. Bozeman, MT: Big Sky Institute. (accessed May 2010).

Schlesinger, M.D., J.D. Corser, K.A. Perkins, and E.L. White. 2011. Vulnerability of at-risk species to climate change in New York. New York Natural Heritage Program, Albany, NY.

Tuskes, P. M., J. P. Tuttle, and M. M. Collins. 1996. The Wild Silk Moths of North America: A Natural History of the Saturniidae of the United States and Canada. Cornell University Press, Ithaca, New York. 250 pp.

Wagner, David L., Nelson, Michael W., and Schweitzer, Dale F. 2003. Shrubland Lepidoptera of southern New England and southeastern New York: ecology, conservation, and management. Forest Ecology and Management 185: 95-112.

New York Natural Heritage Program
625 Broadway, 5th Floor,
Albany, NY 12233-4757
Phone: (518) 402-8935
acris@nynhp.org

This project is made possible with funding from:
- New York State Department of Environmental Conservation Hudson River Estuary Program
- Division of Lands & Forests, Department of Environmental Conservation
- New York State Office of Parks, Recreation and Historic Preservation

Information for this guide was last updated on Mar 18, 2013
This guide was authored by Andrea Chaloux

www.vhb.com

December 15, 2014

VIA ELECTRONIC MAIL

Ref: 28409.00

Ms. Andrea Chaloux
Information Services
New York Natural Heritage Program
New York State Department of
Environmental Conservation
625 Broadway, 5th Floor
Albany, New York 12233-4757

Re: Request for Additional Information
Proposed Subdivision of EPCAL Property at Calverton
Calverton, Town of Riverhead
Suffolk County, New York
Suffolk County Tax Map Nos.: District 0600 - Section 135.00 – Block 01.00 –
Lots 007.001,007.002,007.029,007.033 and 007.004

Dear Ms. Chaloux:

VHB Engineering, Surveying and Landscape Architecture, P.C. (VHB) is serving as a consultant to the Town of Riverhead Town Board (as lead agency), for the proposed subdivision and redevelopment of portions of the 2,323.9± acre Enterprise Park at Calverton (EPCAL) property, located in the hamlet of Calverton, Town of Riverhead, Suffolk County (the "subject property"). Pursuant to VHB's January 24, 2014 request, the New York Natural Heritage Program (NYNHP) provided a list of records for rare and New York State-listed plants, wildlife and significant natural communities at and in the vicinity of the subject property, dated February 7, 2014 (copies of VHB and NYNHP correspondence enclosed). The records list was utilized as part of the rare/protected species assessment included as part of the Comprehensive Habitat Protection Plan (CHPP) and Draft Supplemental Generic Environmental Impact Statement (DSGEIS) for the proposed action. Currently, VHB is in the process of preparing a Final Supplemental Generic Environmental Impact Statement (FSGEIS) for the proposed action.

As part of the FSGEIS process, VHB must respond to comments issued by the New York State Department of Environmental Conservation (NYSDEC) Region 1 Office, in correspondence dated October 10, 2014. Specifically, the NYSDEC Region 1 Office has requested that VHB contact the NYNHP in order that we may provide more detailed information regarding the NYNHP rare/protected species and habitat records identified for the subject property and vicinity. In particular, the NYSDEC is requesting that VHB provide

100 Motor Parkway
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Hauppauge, New York 11788
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F 631.813.2545

a detailed discussion of the eight on-site and two off-site tiger salamander breeding ponds in the DEIS, and that the location of the breeding ponds and their associated buffer areas be incorporated into the property mapping. Accordingly, VHB respectfully requests that any and all available information for the individual species records included in the NYNHP's February 7, 2014 correspondence be provided, including the locations of the eight on-site and two off-site tiger salamander breeding ponds.

Thank you in advance for your assistance. If additional information is required, or if you have any questions, please do not hesitate to contact me.

Sincerely,

VHB Engineering, Surveying and Landscape Architecture, P.C.

David Kennedy
Project Scientist

DK/ba
enc.
cc: Mr. Robert Marsh, Regional Natural Resources Supervisor, NYSDEC

VHB Planning | Transportation | Land Development | Environmental Services

Creating results for our clients and benefits for our communities

January 24, 2014

VIA ELECTRONIC MAIL

Ref: 28409.00

Ms. Tara Salerno
Information Services
New York Natural Heritage Program
New York State Department of
Environmental Conservation
625 Broadway, 5th Floor
Albany, New York 12233-4757

Re: Proposed Subdivision of EPCAL Property at Calverton
Calverton, Town of Riverhead
Suffolk County, New York
Suffolk County Tax Map Nos.: District 0600 - Section 135.00 – Block 01.00 –
Lots 007.001,007.002,007.029,007.033 and 007.004

Dear Ms. Salerno:

VHB Engineering, Surveying and Landscape Architecture, P.C. (VHB) is serving as engineering and environmental consultant to the Town of Riverhead, for the proposed subdivision and phased redevelopment of portions of the former Calverton Naval Weapons Industrial Reserve Plant (NWIRP) property, also known as the Enterprise Park at Calverton (EPCAL) property (the "subject property"). The 2,323.9± acre subject property is located to the south of Middle Country Road (New York State Route 25), North of Grumman Boulevard, west of Wading River Manor Road, and approximately 5,900± Feet west of Edwards Avenue, in the hamlet of Calverton, Town of Riverhead, Suffolk County (see enclosed excerpt of the USGS Topographic Map, Wading River, New York Quadrangle). The subject property currently supports both undeveloped and developed habitat types, including grasslands, woodlands, wetlands, surface water bodies, and areas developed with buildings and pavement. As part of the environmental review process for the proposed redevelopment, VHB has been contracted by our client to prepare a Draft Supplemental Generic Environmental Impact Statement (DSGEIS), with the Town of Riverhead Town Board acting as the lead agency.

In order to ensure that the DSGEIS will address all significant issues, we are writing to ask whether there are any New York Natural Heritage Program records of rare plants, animals and/or natural communities or significant wildlife habitats on, or proximate to, the subject property.

VHB Engineering, Surveying
and Landscape Architecture, P.C.
2150 Joshua's Path, Suite 300
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Thank you in advance for your assistance. If additional information is required, or if you have any questions, please do not hesitate to contact me.

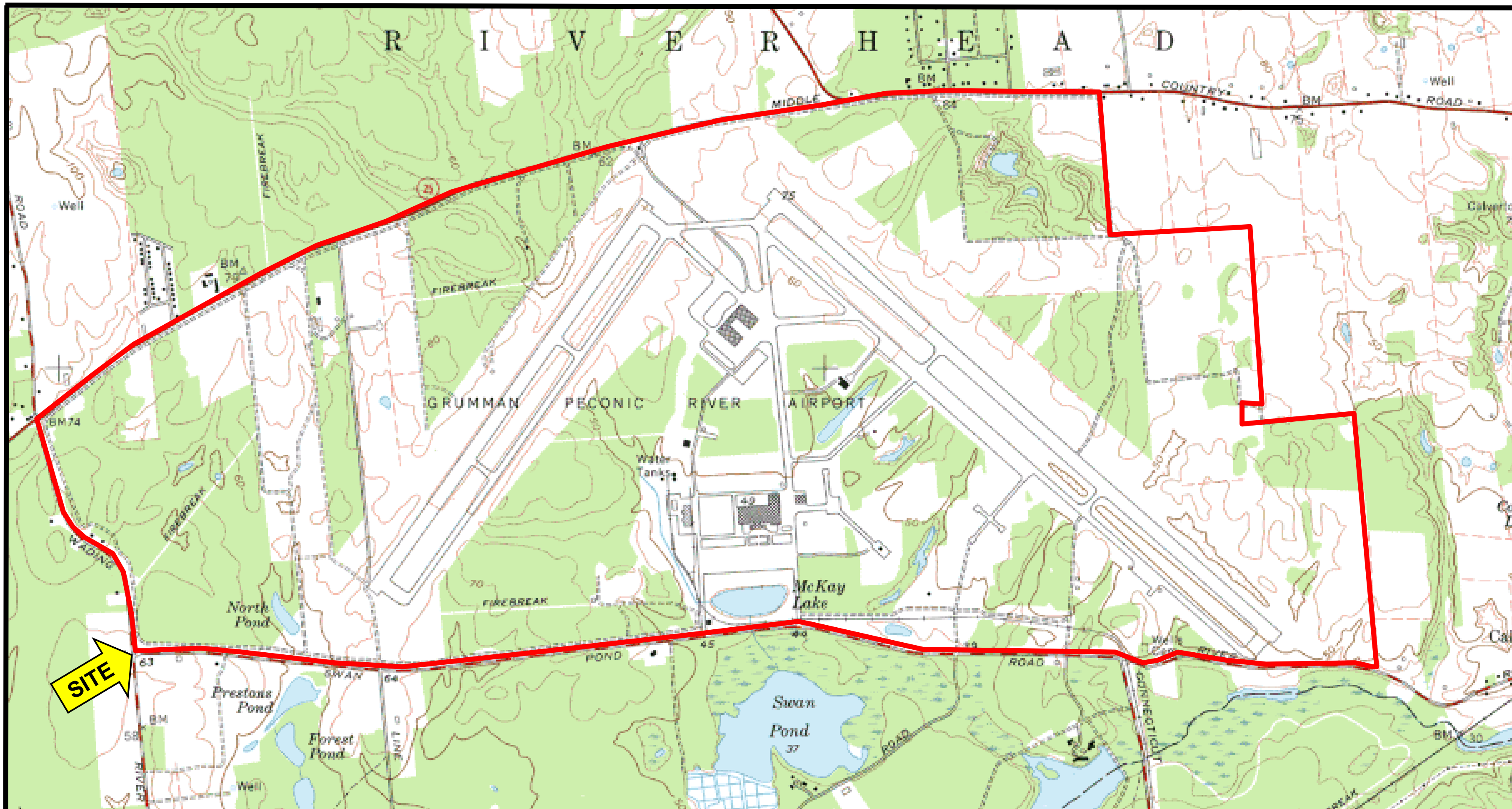
Sincerely,

VHB Engineering, Surveying and Landscape Architecture, P.C.

David Kennedy
Project Scientist

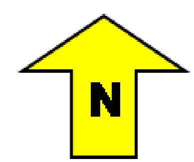
DK/lm
enc.

VHB



EXCERPT OF USGS TOPOGRAPHIC MAP

SITE NAME: EPCAL Property
CITY, STATE, ZIP: Calverton, New York 11933
SUFFOLK COUNTY TAX MAP NUMBER: District 0600 – Section 135.00 – Block 01.00 – Lots 007.001, 007.002, 007.029, 007.033 and 007.004
BASE MAP SOURCE: USGS Topographic Map – Wading River, New York Quadrangle



NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION
Division of Fish, Wildlife & Marine Resources
New York Natural Heritage Program
625 Broadway, 5th Floor, Albany, New York 12233-4757
Phone: (518) 402-8935 • **Fax:** (518) 402-8925
Website: www.dec.ny.gov

Joe Martens
Commissioner

February 07, 2014

David Kennedy
VHB Engineering, Surveying and Landscape Architecture, P.C.
2150 Joshua's Path, Suite 300
Hauppauge, NY 11788

Re: Proposed subdivision and redevelopment of EPCAL property at Calverton
Town/City: Riverhead. County: Suffolk.

Dear David Kennedy :

In response to your recent request, we have reviewed the New York Natural Heritage Program database with respect to the above project

Enclosed is a report of rare or state-listed animals and plants, and significant natural communities, which our databases indicate occur, or may occur, on your site or in the immediate vicinity of your site.

For most sites, comprehensive field surveys have not been conducted; the enclosed report only includes records from our databases. We cannot provide a definitive statement as to the presence or absence of all rare or state-listed species or significant natural communities. Depending on the nature of the project and the conditions at the project site, further information from on-site surveys or other sources may be required to fully assess impacts on biological resources.

Our databases are continually growing as records are added and updated. If this proposed project is still under development one year from now, we recommend that you contact us again so that we may update this response with the most current information.

The presence of the plants and animals identified in the enclosed report may result in this project requiring additional review or permit conditions. For further guidance, and for information regarding other permits that may be required under state law for regulated areas or activities (e.g., regulated wetlands), please contact the appropriate NYS DEC Regional Office, Division of Environmental Permits, as listed at www.dec.ny.gov/about/39381.html.

Sincerely,

Andrea Chaloux

Andrea Chaloux
Environmental Review Specialist
New York Natural Heritage Program

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The following state-listed animals have been documented at your project site, or in its vicinity.

The following list includes animals that are listed by NYS as Endangered, Threatened, or Special Concern; and/or that are federally listed or are candidates for federal listing. The list may also include significant natural communities that can serve as habitat for Endangered or Threatened animals, and/or other rare animals and rare plants found at these habitats.

For information about potential impacts of your project on these populations, how to avoid, minimize, or mitigate any impacts, and any permit considerations, contact the Wildlife Manager or the Fisheries Manager at the NYSDEC Regional Office for the region where the project is located. A listing of Regional Offices is at http://www.dec.ny.gov/about/558.html.

The following species and habitats have been documented at or near the project site, generally within 0.5 mile. Potential onsite and offsite impacts from the project may need to be addressed.

COMMON NAME	SCIENTIFIC NAME	NY STATE LISTING	FEDERAL LISTING	
Birds				
Short-eared Owl onsite *Nonbreeding*	*Asio flammeus*	Endangered		13216
Amphibians				
Tiger Salamander onsite	*Ambystoma tigrinum*	Endangered		529
Fish				
Banded Sunfish	*Enneacanthus obesus*	Threatened		2872

This report only includes records from the NY Natural Heritage databases. For most sites, comprehensive field surveys have not been conducted, and we cannot provide a definitive statement as to the presence or absence of all rare or state-listed species. Depending on the nature of the project and the conditions at the project site, further information from on-site surveys or other sources may be required to fully assess impacts on biological resources.

If any rare plants or animals are documented during site visits, we request that information on the observations be provided to the New York Natural Heritage Program so that we may update our database.

Information about many of the listed animals in New York, including habitat, biology, identification, conservation, and management, are available online in Natural Heritage's Conservation Guides at www.guides.nynhp.org, and from NYSDEC at http://www.dec.ny.gov/animals/7494.html.

Information about many of the rare plants and animals, and natural community types, in New York are available online in Natural Heritage's Conservation Guides at www.guides.nynhp.org, and from NatureServe Explorer at http://www.natureserve.org/explorer.

The following rare plants, rare animals, and significant natural communities have been documented at your project site, or in its vicinity.

We recommend that potential onsite and offsite impacts of the proposed project on these species or communities be addressed as part of any environmental assessment or review conducted as part of the planning, permitting and approval process, such as reviews conducted under SEQR. Field surveys of the project site may be necessary to determine the status of a species at the site, particularly for sites that are currently undeveloped and may still contain suitable habitat. Final requirements of the project to avoid, minimize, or mitigate potential impacts are determined by the lead permitting agency or the government body approving the project.

The following animals, while not listed by New York State as Endangered or Threatened, are of conservation concern to the state, and are considered rare by the New York Natural Heritage Program.

COMMON NAME	SCIENTIFIC NAME	NY STATE LISTING	HERITAGE CONSERVATION STATUS

Reptiles

Eastern Wormsnake	*Carphophis amoenus*	Special Concern	Imperiled in NYS

River Road, 2007-09-13: The snake was found at the edge of an old clearing along the south side of River Road. This area has sandy soils, white oak, pin oak, pitch pine, grasses, and moss and appears similar to a pine barrens community. 12701

Moths

Coastal Barrens Buckmoth	*Hemileuca maia ssp. 5*	Special Concern	Imperiled in NYS and Globally Uncommon

Middle Country Road Woods, 2002-06-18: Pitch pine oak heath woodland and pitch pine oak forest with scrub oak and and other oaks. This area was burned in 1981. 867

Coastal Barrens Buckmoth	*Hemileuca maia ssp. 5*	Special Concern	Imperiled in NYS and Globally Uncommon

Firebreak Pond East, 1987-10-19: The moths were trapped on a military airport surrounded by fire-suppressed pine-oak woods. The areas around the runways are kept low by mowing and tree cutting. The northeast section burned in 1984. 8051

The following significant natural communities are considered significant from a statewide perspective by the NY Natural Heritage Program. They are either occurrences of a community type that is rare in the state, or a high quality example of a more common community type. By meeting specific, documented criteria, the NY Natural Heritage Program considers these community occurrences to have high ecological and conservation value.

COMMON NAME	SCIENTIFIC NAME	NY STATE LISTING	HERITAGE CONSERVATION STATUS

Wetland/Aquatic Communities

Coastal Plain Pond Shore			High Quality Occurrence of Rare Community Type

Third Pond Calverton: Excellent sandy margins. Little emergent vegetation. Little disturbance. 8257

Upland/Terrestrial Communities

Pitch Pine-Oak Forest High Quality Occurrence

Sandy Pond East: The occurrence is good sized with good species composition. The area is part of the much larger central Long Island pine barrens. 10254

The following plants are listed as Endangered or Threatened by New York State, and/or are considered rare by the New York Natural Heritage Program, and so are a vulnerable natural resource of conservation concern.

COMMON NAME	SCIENTIFIC NAME	NY STATE LISTING	HERITAGE CONSERVATION STATUS

Vascular Plants

Comb-leaved Mermaid-weed	*Proserpinaca pectinata*	Threatened	Imperiled in NYS

Third Pond Calverton, 2000-08-03: This is a shallow, dark water pond with an extensive exposed margin on the east side of the pond and set in a Pinus rigida dominated pine barrens. The plants are in the sandy upper margin of a coastal plain pond. 819

Rose Coreopsis	*Coreopsis rosea*	Rare	Vulnerable in NYS and Globally Uncommon

Calverton Woods, 2005-07-26: This is a small, shallow pond set in a remote section of the pine barrens. No paths lead to the pond. The plants are on a dry margin of a small coastal plain pond. 921

Small Floating Bladderwort	*Utricularia radiata*	Threatened	Imperiled in NYS

Forest Pond, 1985-08-09: This is a small, shallow pond set in pine barrens. 1984: There are low water conditions. 996

Short-beaked Beakrush	*Rhynchospora nitens*	Threatened	Imperiled in NYS

Forest Pond, 2005-09-13: This is a shallow coastal plain pond set in oak-dominated pine barrens. 962

Small Floating Bladderwort	*Utricularia radiata*	Threatened	Imperiled in NYS

Prestons Pond, 1984-08-10: This is a shallow coastal plain pond set in pine barrens. 3046

Rose Coreopsis	*Coreopsis rosea*	Rare	Vulnerable in NYS and Globally Uncommon

Forest Pond, 2005-07-26: This is a shallow coastal plain pond set in oak-dominated pine barrens. 3061

Coppery St. John's-wort	*Hypericum denticulatum*	Endangered	Critically Imperiled in NYS

Third Pond Calverton, 1996-su: The plants are in a shallow, dark water pond with an extensive exposed margin on the east side set in a Pinus rigida dominated pine barrens. The upper pond margin is in a sand substrate. 2678

Pine Barren Bellwort	*Uvularia puberula*	Endangered	Critically Imperiled in NYS

Swan Pond, 1987-05-20: A wet pine barrens woodland with open light under the mixed pine-deciduous canopy. 4542

Slender Pinweed	*Lechea tenuifolia*	Threatened	Imperiled in NYS

North Pond Firebreak Road, 1986-10-10: Bulldozed mounds along firebreak. 4099

Rose Coreopsis	*Coreopsis rosea*	Rare	Vulnerable in NYS and Globally Uncommon

North Pond Riverhead, 1987-08-10: The plants are on a very grassy coastal plain pond with low diversity and set in a pine barrens near an airport runway apron. 4900

American Ipecac	*Euphorbia ipecacuanhae*	Endangered	Critically Imperiled in NYS

Swan Pond, 2000-08-03: A sandy pebbly roadside in open sand with little competition. 5182

Slender Crabgrass	*Digitaria filiformis*	Endangered	Critically Imperiled in NYS

Linus Pond, 1987-10-03: The plants are on a sandy wet road through wet pine barrens. The site is dominated by red maple, pitch-pine, Nyssa, and Clethra. 4786

Short-beaked Beakrush	*Rhynchospora nitens*	Threatened	Imperiled in NYS

Third Pond Calverton, 2005-09-13: The plants are in a shallow, dark water pond with an extensive exposed margin on the east side set in Pinus rigida dominated pine barrens. There are dense stands in the sandy exposed margin. 6252

Slender Pinweed	*Lechea tenuifolia*	Threatened	Imperiled in NYS

Middle Country Road Margin, 1985-08-06: A periodically mowed roadside in a developed area. 7061

Small Floating Bladderwort	*Utricularia radiata*	Threatened	Imperiled in NYS

Third Pond Calverton, 1991-09-10: This is a small, circular, pine barrens, dark water pond with a low diversity emergent vegetation zone. 6736

Tooth-cup	*Rotala ramosior*	Threatened	Imperiled in NYS

Conoe Pond, 1984-09: Elongate pond set in woods surrounded by farm fields with sand pits along east side. Pond shore. 9029

Comb-leaved Mermaid-weed	*Proserpinaca pectinata*	Threatened	Imperiled in NYS

Forest Pond, 2005-09-13: This is a shallow coastal plain pond set in oak-dominated pine barrens. The plants are on the sandy margin of a dry coastal plain pond. 9545

Rose Coreopsis	*Coreopsis rosea*	Rare	Vulnerable in NYS and Globally Uncommon

Third Pond Calverton, 2005-09-13: The plants are in a shallow, dark water pond with an extensive exposed margin on the east side set in a Pinus rigida dominated pine barrens. The upper pond margin is in a sand substrate. 8208

Comb-leaved Mermaid-weed	*Proserpinaca pectinata*	Threatened	Imperiled in NYS

Calverton Woods, 2005-07-26: This is a shallow pond set in oak-pine woods and Vaccinium corymbosum thickets in a larger pine barrens landscape. 5211

Wright's Panic Grass	*Dichanthelium wrightianum*	Endangered	Critically Imperiled in NYS

Third Pond Calverton, 2005-09-13: The plants are in a small circular pine barrens pond with low diversity emergent vegetation zone. The plants are on the exposed margin of the coastal plain pond shore. 10592

This report only includes records from the NY Natural Heritage databases. For most sites, comprehensive field surveys have not been conducted, and we cannot provide a definitive statement as to the presence or absence of all rare or state-listed species. Depending on the nature of the project and the conditions at the project site, further information from on-site surveys or other sources may be required to fully assess impacts on biological resources.

If any rare plants or animals are documented during site visits, we request that information on the observations be provided to the New York Natural Heritage Program so that we may update our database.

Information about many of the rare animals and plants in New York, including habitat, biology, identification, conservation, and management, are available online in Natural Heritage's Conservation Guides at www.guides.nynhp.org, from NatureServe Explorer at http://www.natureserve.org/explorer, and from USDA's Plants Database at http://plants.usda.gov/index.html (for plants).

Information about many of the natural community types in New York, including identification, dominant and characteristic vegetation, distribution, conservation, and management, is available online in Natural Heritage's Conservation Guides at www.guides.nynhp.org. For descriptions of all community types, go to http://www.dec.ny.gov/animals/29384.html and click on Draft Ecological Communities of New York State.

The following rare plants and rare animals have historical records at your project site, or in its vicinity.

The following rare plants and animals were documented in the vicinity of the project site at one time, but have not been documented there since 1979 or earlier, and/or there is uncertainty regarding their continued presence. There is no recent information on these plants and animals in the vicinity of the project site and their current status there is unknown. In most cases the precise location of the plant or animal in this vicinity at the time it was last documented is also unknown.

If suitable habitat for these plants or animals is present in the vicinity of the project site, it is possible that they may still occur there. We recommend that any field surveys to the site include a search for these species, particularly at sites that are currently undeveloped and may still contain suitable habitat.

COMMON NAME	SCIENTIFIC NAME	NYS LISTING	HERITAGE CONSERVATION STATUS
Amphibians			
Northern Cricket Frog	*Acris crepitans*	Endangered	Critically Imperiled in NYS
1928-05-16:			7586
Tiger Salamander	*Ambystoma tigrinum*	Endangered	Critically Imperiled in NYS
2002-03-10: The salamanders were found in a small pond/pool. Soon after, the pond was converted into a rip-rapped drainage ditch. The ditch has an oak leaf litter and grass substrate. The -- See HOTLINK for full text.			12618
Beetles			
New Jersey Pine Barrens Tiger Beetle	*Cicindela patruela consentanea*	Unlisted	Historical Records Only in NYS and Globally Rare
1946-05-07: Calverton.			1539
Vascular Plants			
Marsh Straw Sedge	*Carex hormathodes*	Threatened	Imperiled in NYS
1927-07-02: Calverton. Moist woods.			164
Primrose-leaf Violet	*Viola primulifolia*	Threatened	Imperiled in NYS
1927-05-29: Calverton. Moist, open ground.			3039
Atlantic White Cedar	*Chamaecyparis thyoides*	Threatened	Imperiled in NYS
1923-11-17: Calverton.			4540

COMMON NAME	SCIENTIFIC NAME	NYS LISTING	HERITAGE CONSERVATION STATUS
Silvery Aster	*Symphyotrichum concolor var. concolor*	Endangered	Critically Imperiled in NYS
1873-09-11: Calverton.			4450
Stargrass	*Aletris farinosa*	Threatened	Imperiled in NYS
1927-08-12: Calverton. Specimen label: Low, wet gravelly soil.			6474
Great Plains Flatsedge	*Cyperus lupulinus ssp. lupulinus*	Threatened	Imperiled in NYS
1955-09-09: Calverton. Dry sandy soil.			5807
Carolina Redroot	*Lachnanthes caroliniana*	Endangered	Critically Imperiled in NYS
1941-09-06: Forest Pond.			6088
Catfoot	*Pseudognaphalium helleri ssp. micradenium*	Endangered	Historical Records Only in NYS and Globally Uncommon
1929-09-15: Manorville.			6810
Flax-leaf Whitetop	*Sericocarpus linifolius*	Threatened	Imperiled in NYS
1927-08-14: Calverton.			5471
Rose Coreopsis	*Coreopsis rosea*	Rare	Vulnerable in NYS and Globally Uncommon
1979-08-09: Sandpit Pond River Road.			9394
Coppery St. John's-wort	*Hypericum denticulatum*	Endangered	Critically Imperiled in NYS
1923-07-22: Manorville. Wet meadows, pine barren. Border of ponds.			9085
Autumnal Water-starwort	*Callitriche hermaphroditica*	Endangered	Critically Imperiled in NYS
1927-08-12: Calverton. In water, river.			9337

This report only includes records from the NY Natural Heritage databases. For most sites, comprehensive field surveys have not been conducted, and we cannot provide a definitive statement as to the presence or absence of all rare or state-listed species. Depending on the nature of the project and the conditions at the project site, further information from on-site surveys or other sources may be required to fully assess impacts on biological resources.

If any rare plants or animals are documented during site visits, we request that information on the observations be provided to the New York Natural Heritage Program so that we may update our database.

Information about many of the rare animals and plants in New York, including habitat, biology, identification, conservation, and management, are available online in Natural Heritage's Conservation Guides at www.guides.nynhp.org, from NatureServe Explorer at http://www.natureserve.org/explorer, and from USDA's Plants Database at http://plants.usda.gov/index.html (for plants).

NORTHEAST GRASSLAND and SALTMARSH BIRD WORKING GROUP NEWSLETTER
Partners in Flight - Fall 1999

Compiled by: Grassland/Saltmarsh Conservation Program, Center for Biological Conservation, Massachusetts Audubon Society, 208 South Great Road, Lincoln, MA 01773. Additional copies can be obtained from Andrea Jones, 781-259-9506 x 7406, ajones@massaudubon.org.

NEW YORK

GRASSLAND BIRD COMMUNITIES ON THE FORT DRUM MILITARY RESERVATION

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The fieldwork for Fort Drum's Grassland Bird study has been completed and a final report is currently being prepared. The objectives of the study include determining the impact of military training maneuvers on grassland birds and their habitat, and assessing nest success for birds breeding in the grassland training areas. Training use was negatively correlated with woody-stemmed vegetation, while analysis of bird abundance relative to training use revealed positive trends for the percent occurrence of Eastern Meadowlark and Savannah Sparrow, and a negative trend for Field Sparrow. Thus suggesting that training use may help to retard the growth of woody-stemmed vegetation, resulting in increased incidence of some species of grassland-dependent birds. Over the past three years, more than 150 nests were located and monitored, most of which belonged to either Bobolink or Savannah Sparrow. Nest success for both species was comparable to that reported in the literature for other locations, suggesting that military training, while helping to retard succession, is not leading to unusually high nest mortality among grassland birds. Fort Drum's ongoing Henslow's Sparrow study should provide additional information regarding the potential impact of training use on the productivity of grassland birds on the installation.

This past field season was the second of a three-year study on Fort Drum to determine the population status and breeding biology of Henslow's Sparrow on the installation. In 1999, Henslow's Sparrow abundance was estimated at 35 pairs, down from 40 pairs the previous year. Twenty-seven birds were mist-netted and color-banded, and five birds from last year were also recaptured. Several males were captured and fitted with radio transmitters to help determine territories, in two of which, nests were located. One nest had been abandoned, while the second nest successfully fledged two young. Data collection will continue through 2000, and a final report is expected by December 2001.

Fort Drum's Land Condition Trend Analysis (LCTA) program completed its ninth year of data collection in 1999. The purpose of the LCTA program is to monitor the effects of military training on the environment, as well as to monitor long-term trends in bird populations. Each year, point-count surveys are conducted at more than 200 permanent sampling locations in various habitats throughout the installation, including 35 sampling points located in grassland habitat. While not enough data have been compiled thus far to detect any meaningful population trends, over the past several years the five most abundant grassland bird species has remained the same (Bobolink, Savannah Sparrow, Vesper Sparrow, Henslow's Sparrow, and Eastern Meadowlark). Fort Drum has also been operating two MAPS banding stations since 1992, one of which is located in an early successional habitat. Over the past eight years, this station has had a total of 54 species and 3,628 captures. Of this total, four Bobolinks, two Savannah Sparrows, and one Henslow's Sparrow, represent the only grassland bird captures at the site.

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GRASSLAND BIRD RESEARCH - WESTERN AND CENTRAL NEW YORK

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My students and I continued work on three research projects during 1999. First, Karla Balent finished the third and final field season of her project on the spatial structure of a Grasshopper Sparrow population in the Mendon Ponds area, which has apparently declined in size since she began her project in 1997. Karla currently is analyzing her data in preparation for writing her thesis. Second, Robin Krebs completed the second of three field seasons on the breeding ecology and habitat selection of Henslow's Sparrows at Fort Drum Military Reservation in Jefferson County, NY. Robin censused grasslands throughout Fort Drum, banded birds, placed radio telemetry devices on a subset of these birds, and carried out detailed vegetation analyses. Third, I continued my long-term monitoring of fields at Iroquois and Montezuma National Wildlife Refuges, including those that have been the subject of management activities designed to improve grassland bird habitat. A student and I also surveyed Jefferson County fields outside of Fort Drum for Henslow's Sparrows. In collaboration with Nick Leone, a local Henslow's Sparrow enthusiast, we have identified 66 fields within 20 km of Watertown that have contained the species since 1994. The maximum number of fields known to be occupied by singing males was 40 in 1998. The cluster of fields in the Jefferson County area, along with those at Fort Drum, must support the largest known population of Henslow's Sparrows in the region. Finally, in March 1999 I completed an extensive final report for the US Fish and Wildlife Service on grassland bird research carried out primarily between 1994 and 1997 at Iroquois and Montezuma National Wildlife Refuges. Copies of this report can be requested by contacting me at cnorment@brockport.edu. As always, thanks to the US Fish and Wildlife Service, New York State Department of Environmental Conservation, and the Department of Defense for supporting my research on grassland birds.

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GRASSLAND BIRD SURVEYS IN NEW YORK

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I was hired by Massachusetts Audubon Society as the researcher for the 1999 grassland bird nesting season in New York State. I surveyed a total of 932 points in 23 counties between late-May and mid-August. I covered a large geographic area in New York, from the western part of New York, south of Buffalo and to the tip of Long Island. The number of birds tallied, particularly Henslow's Sparrow, was most exciting!

Besides following the set protocol for diurnal sampling, I also organized a volunteer night Henslow's Sparrow survey throughout New York. During the night of June 13-14, 7 others and myself went to known Henslow's Sparrow locations and listened once again. In 5 of the 7 locations, additional singing males were detected. The total number tallied for the season, including night counts, was 80. High concentrations were found in the Rochester area (Livingston County) and the southern portion of Steuben County.

Numbers are as follows: BOBO 1512, EAME 418, GRSP 362, HESP 51, HOLA 20, NOHA 7, RWBL 1637, SASP 1238, UPSA 41, and VESP 16. I hope to assist in any further counts planned for 2000. Currently, I am working on a written grassland conservation project with Jeff Wells of National Audubon Society.

NEW HAMPSHIRE

SUMMARY OF GRASSLAND BIRD SURVEYS IN NEW HAMPSHIRE AND VERMONT

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Approximately 35 grassland sites were surveyed in New Hampshire and Vermont in the summer of 1999. Sites were almost entirely limited to the Champlain, Connecticut, and Merrimack Valleys, and the NH seacoast. Vermont sites were primarily sites that contained Grasshopper Sparrows in 1997, and NH sites were chosen based on a combination of size and the presence of a relatively high diversity of grassland birds (again, based on 1997 data).

Grasshopper Sparrows were located on roughly half the Vermont sites. More significantly, a total of at least 10 territories were detected at 6 NH sites, a total unprecedented in at least the last two decades in the state. Most were found at relatively small sites, with the exception of the Pease International Tradeport in Portsmouth/Newington, and the Concord airport. Vesper Sparrows were usually found in the same areas as Grasshopper Sparrows, as well as a few sites in the Connecticut Valley. Upland Sandpipers were detected at only 2 sites in each state. The regional stronghold remains the Pease Tradeport, where roughly a dozen pairs are located. An additional pair was present at the Manchester, NH airport, providing the first confirmed evidence of this species for that site.

MAINE

MAINE SALTMARSH BIRD SURVEYS

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Saltmarsh habitats are important brood-rearing areas for waterfowl, foraging areas for wading birds, and nesting areas for a few less common species of songbirds. Nelson's and Saltmarsh Sharp-tailed Sparrows occur almost exclusively in this habitat type. Understanding the status of these species is a conservation priority in the northeast. In Maine, however, even their breeding range is not well-defined. Biologists with the Maine Department of Inland Fisheries and Wildlife are completing the third year of a 3-year coastwide survey of the birds using Maine's saltmarsh resource. The first year of the survey covered just the southern Maine marshes. In the second year, we revisited some of these same sites and expanded northeastward as far as Penobscot Bay. During 1999, our final year, we surveyed the often smaller marshes found along eastern Maine's "Downeast" coast. Knowledge of the distribution and types of saltmarsh habitats occupied by Sharp-tailed Sparrows and others species is important in prioritizing land acquisitions and in oil spill response and mitigation.

MASSACHUSETTS

GRASSHOPPER SPARROW BREEDING BIOLOGY AND METAPOPULATION STUDY

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During the 1999 field season, 2 interns were hired to help with the fourth year of our metapopulation study. In addition, 10 volunteers helped collect data. Grasshopper Sparrows were banded in Massachusetts at Westover Air Reserve Base in Chicopee and on Nashawena Island, where banding has occurred since 1996. Efforts also focused on relocating birds banded at these sites for the past 3 years. In total, 602 birds have been banded at primarily at Westover and Nashawena but also at several smaller populations including Turners Falls Airport, Devens, and Dukes County Airport, Martha's Vineyard. We completed the fourth and final year of evaluating reproductive success in permanent plots at Westover and Nashawena. Reproductive success and banding studies will continue at Hanscom Field and Devens. This data is being collected by long-time volunteer Ron Lockwood.

Banding and reproductive success studies continued at 4 satellite sites in the state. All known Grasshopper Sparrow breeding sites in the state were surveyed at least once to search for dispersed individuals. Several meetings have occurred with managers of both Nashawena and Westover Air Reserve Base to discuss future management options and results of this study. Efforts are also underway to consult with these landowners to discuss the direction of future grassland bird research, conservation, and management techniques.

THE EFFECTS OF HABITAT RESTORATION ON GRASSLAND AND SHRUBLAND BIRDS OF NANTUCKET

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In New England, grassland restoration is a relatively new form of conservation by which grassland is created and sustained through intensive management methods such as prescribed burning and intensive mowing. On Nantucket Island, the

Partnership for Harrier Habitat Preservation (PHHP) is conducting a 50-year grassland management plan aimed at creating over 400 hectares of grassland for the island's population of northern harriers (*Accipiter gentilis*). The Massachusetts Audubon Society is conducting a three-year study addressing the effects of management on declining populations of grassland and shrubland birds.

Management methods, such as prescribed burning and mowing, have potentially significant impacts on bird communities. Several studies in the Midwest have shown that grassland restoration can create and sustain grassland habitat, but research addressing possible negative side effects has been limited. Intensive habitat restoration can, in effect, transform the landscape overnight. The ecological impacts of this dramatic change in habitat must be studied when considering the regional declines of many of the effected species of birds. Considering that many coastal grassland and heathland systems are regionally rare, we must address the effects of these management programs. The use of habitat management can be beneficial in re-creating the natural disturbances that are historically important to New England's fauna and flora; however, there is a critical need to study and analyze the effects of this management on populations of grassland and shrubland birds.

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GRASSLAND BIRD SURVEY AT WESTOVER AIR RESERVE BASE

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I conducted a comprehensive census of grassland birds at Westover Air Reserve Base in Chicopee, Massachusetts during the mornings of 10, 11, 12, 13, 14, and 16 June 1999, with assistance from Andrea Jones and Justin Schoefer of Massachusetts Audubon Society. All grassland areas on the base were censused by walking transects spaced approximately 100 m apart and recording locations of birds detected. Results included: 154 adult Upland Sandpipers, 169 singing male Grasshopper Sparrows, 81 singing male Savannah Sparrows, 91 adult Eastern Meadowlarks, 55 adult male Bobolinks, 74 adult Horned Larks, 15 adult Killdeer, and 18 adult male Red-winged Blackbirds. These totals represent increases over 1997 counts for Upland Sandpipers, Grasshopper Sparrows, and Eastern Meadowlarks. Numbers of Bobolinks, Horned Larks, and Red-winged Blackbirds declined relative to 1997 counts, while counts of Savannah Sparrows and Killdeer were essentially unchanged.

Acreages of grassland and other "tree-less" habitat on the airfield increased slightly in 1999 as the result of capping a small landfill and removing trees at certain locations

to widen clear zones for aircraft safety. MassWildlife provided comments on the Draft Fish and Wildlife/Threatened and Endangered Species Management Plan for the base, and expressed concern that proposed vegetation management, ie. increased frequency of mowing, would degrade the quality of habitat for Grasshopper Sparrows and likely result in direct mortality of eggs and young of Upland Sandpipers and Grasshopper
Sparrows. We also expressed concern that the draft plan failed to provide clear guidelines for the timing and location of parking on grassland habitat for airshows and other public events, and failed to establish clear procedures for review by MassWildlife of proposed construction activities for compliance with our state Endangered Species Act.

RHODE ISLAND

EFFECTS OF GRASSLAND BIRD HABITAT RESTORATION ON BREEDING BIRDS

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The US Fish and Wildlife Service has been restoring grasslands on two refuges in southern Rhode Island for the past three years. During the 1999 field season, we initiated research to quantify the effects of grassland restoration efforts on breeding birds. We spot-mapped eight fields (8 - 40 acres) on Trustom and Ninigret National Wildlife Refuges from late-May to early July. We also quantified vegetation composition at each field. Fifty-one species of birds were detected during fieldwork, of which only a few were grassland obligates. Bobolinks were found nesting in two fields on Trustom NWR, one pair on a 15-acre field dominated by big bluestem *(Andropogon gerardii*), and Timothy grass (*Phleum pratense*), and 2-3 pairs on a 40-acre field where big bluestem, smooth brome-grass (*Bromus inermus*) and three-veined goldenrod (*Euthamia graminifolia*) were abundant. Savannah Sparrows, 2 pairs, were found nesting only in the 40-acre field. In late-July, staging flocks of up 100 Bobolinks were observed foraging in this large, 40-acre field on the southeastern edge of Trustom NWR (we were able to band 17 Bobolinks from these staging flocks). Red-winged Blackbirds were the only grassland bird that nested in every field we surveyed. Other grassland-associated birds (e.g., Eastern Meadowlarks, Northern Harrier, and American Kestrel) were observed foraging in the fields we surveyed, but there was no evidence they nested in the fields we monitored.

Based on our fieldwork, we recommended to US Fish and Wildlife Service staff that they remove shrubs and trees between adjacent fields to increase the size of existing grasslands on Trustom NWR. It is hoped that increasing the grassland acreage might increase the number of Bobolinks, Savannah Sparrows, and meadowlarks in the area. We also recommended that they continue to remove runways, shrubs, and trees at Ninigret NWR to increase the grassland acreage on that refuge. We hope to continue monitoring the grassland restoration efforts on these refuge lands for the next several years.

CONNECTICUT

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Grassland bird surveys were conducted throughout Connecticut by volunteers and volunteer coordinator Peter Houlihan, used standard point count methods. Massachusetts Audubon's Grassland Conservation Program was contracted to conduct a study of grassland bird productivity at Bradley International Airport in Windsor, CT. Peter Houlihan was hired to conduct the survey and write a final report. Permanent point counts were established as well as a permanent plot to monitor reproductive success of Grasshopper Sparrows, Savannah sparrow, and Bobolinks. Although the airport agreed not to mow the airport in known grassland bird breeding locations, data showed very low reproductive activity this year, most likely due to extreme drought conditions. Recommendations for continued monitoring and management of grassland birds at the airport were presented to airport personnel. For a copy of this report, please contact Jenny Dickson or Andrea Jones.

NEW JERSEY

GRASSLAND RESTORATION

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The Phillipsburg Riverview Organization acquired a 128-acre parcel in Warren County, New Jersey that is part of an area known as the Alpha or Pohatcong Grasslands. It is a breeding site for 5 state-listed T&E grassland bird species. Over-wintering T&E species include Northern Harrier and Short Eared Owl. The property has been farmed for many years in rotating grain crops and our organization decided to establish a mixture of warm season grasses on 80 acres of the parcel. Forty acres were planted during the last week of May and first week of June. Approximately 20 acres were left fallow and the balance was leased to a local farmer who planted corn and soybeans. Unfortunately, our immediate area experienced the most severe drought on record this summer and it started as soon as the crop was planted. We had only one significant rainfall between the time we planted and some time at the end of August. There is speculation that many of the seeds might not have germinated and may survive to germinate at a later time. Since warm season grasses are slow to establish themselves, it will be some time before we will be able to truly assess the damage. The lesson here is that even though these grasses can be planted as late as the end of June, the weather can become very dry in this region during the months of July and August and late planting could be risky.

Another miscalculation was an inadequate program of weed control almost from the inception. As a result we have a problem with Canada Thistle and Johnson Grass that has caused some alarm among the neighboring farmers. The difficulties posed by exotic and aggressive plant species have not yet been fully appreciated by the organization. The good news is that the mixture of clumpy weeds and bare ground seem to have provided good habitat for our rarest species, vesper sparrow.

PENNSYLVANIA

PRELIMINARY RESULTS OF THE 1999 GRASSLAND BIRD SURVEYS IN PENNSYLVANIA

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NE Regional grassland survey point count protocols were used on randomly selected reclaimed mines in Pennsylvania during 1999. A total of 167 points were completed by two short-term employees in a seven-county area. In addition to point counts, line transects (distance data) and detailed vegetation sampling were conducted. This survey was designed to obtain an estimate of populations of three grassland sparrows (Grasshopper, Savannah, and Henslow's) on reclaimed mines in western Pennsylvania. Future analysis will link density estimates with GIS landcover data in order to compute an estimate of the population of these species. GIS analysis and surveys were funded by the Pennsylvania Game Commission and the USFWS Section 6 program.

More than a thousand birds were counted on the 167 points, inclusive of more than 300 Red-winged Blackbirds, 196 Eastern Meadowlarks, and 156 Bobolinks. The most frequently encountered of the sparrows was the Grasshopper Sparrow, with a total of 229 on point counts. A total of 197 Henslow's Sparrows and 127 Savannah Sparrows were also counted. Just two Upland Sandpipers were detected. Henslow's Sparrow populations were not uniformly common on reclaimed surface mines. High counts were found at traditional hot-spots in Clarion County, but good numbers were also found in other counties of northwestern Pennsylvania and in isolated locations to the south.

REGIONAL

REGIONAL GRASSLAND BIRD PROGRAM

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During the 1999 field season, we hired 6 interns to continue our regional survey started in 1997. Our goal during this field season was to survey areas not adequately covered in 1997 and revisit top sites in each state. For each state, we identified the best sites in each state, based on species abundance and presence of rare species - Upland Sandpiper, Grasshopper Sparrow, Vesper Sparrow, and/or Henslow's Sparrow. In addition, we targeted gaps in the 1997 data such as western and southern New York and the Champlain Valley in Vermont. Data was collected using the same point-count method used in 1997 and interns established landowner contact at most sites. In addition, interns also recruited and managed volunteers to help with surveys. Below is a summary of estimated number of sites surveyed in each state.

STATE	# SITES
NY	148
MA	55
CT	20
RI	5
NH/E. VT	36
VT	20
ME	48
TOTAL	**332**

Grassland sites in New York were concentrated within a 300-mile radius of Ithaca, western NY and the Finger Lakes, and southern NY, including Long Island. Efforts in New York were particularly focused on finding additional breeding sites for Henslow's Sparrows; night time surveyed were incorporated to increase delectability. Staff at the National Audubon Society in New York participated in organizing survey effort. Grassland sites in New Hampshire focused on large farmlands and regional airports. Efforts in Vermont were concentrated on many small airports in the state and farmlands in northern Vermont. Vermont Audubon Council and Vermont Fish and Game coordinated surveys with volunteers. In addition, in consultation with the Massachusetts Audubon Society, Vermont Audubon Council distributed management recommendations to airport managers throughout the state. Efforts in Maine were concentrated on large grassland bird breeding areas in blueberry barrens in eastern Maine. Additional surveys were conducted to locate Short-eared Owl breeding areas. All surveys in Maine were coordinated by Maine Inland Fisheries and Wildlife. In Massachusetts, surveys were concentrated on revisiting top sites first surveyed in 1993-1995 and also on sites selected by Silvio Conte National Fish and Wildlife Refuge in the Connecticut River Valley. Surveys were also coordinated with the Massachusetts Division of Fisheries and Wildlife. Efforts in Massachusetts also focused on large grasslands at military bases. Sites in Connecticut were selected and organized by Connecticut Department of Environmental Protection.

New Grassland Bird Book!! Proceedings of the International Grassland Bird Conference in Oklahoma in 1995 are now available. **Ecology and Conservation of Grassland Birds of the Western Hemisphere**, Peter D. Vickery and James R. Herkert, editors, can be ordered by sending $25 (includes postage/handling) to: Cooper Ornithological Society, c/o Western Foundation of Vertebrate Zoology, 439 Calle San Pablo, Camarillo, CA 93010. Make check payable to Cooper Ornithological Society.

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REGIONAL SALT MARSH BIRD PROGRAM

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The first field season of the New England Salt Marsh Breeding Bird Survey was completed 13 August 1999 with 155 salt marshes surveyed between Greenwich, CT and Rye, NH. Five interns were hired throughout the four state region (CT, RI, MA, and NH) in the spring and all were trained in the survey protocol prior to data collection. We met with local researchers and state agencies in all states to inform them about the project and encourage participation. An important goal of this project was to establish contacts and coordinate with ongoing researchers, and to solicit the assistance of local volunteers for the survey work. We now have many contacts and volunteers that have committed to “adopting a marsh” for future survey and monitoring work. We coordinated with the USFWS by providing them with our survey protocol which they plan to use on refuge property throughout USFWS Region 5. We also coordinated with the Global Program of Action for the Gulf of Maine to assist with determining the effects of salt marsh restoration projects on breeding birds and provided our survey protocol to insure standardization of data collection.

Avian and vegetation data were collected on 661, 100 m radius circular points throughout the four state region (Table 1). All points were visited at least twice between 1 June and 13 August to sample breeding birds. Vegetation profiles at each point were collected to determine differences in regional patterns of habitat use and availability. Data are being entered into a database for future analysis. Contacts have been made to acquire GIS coverages of salt marsh habitat on a state level to provide base maps to display the distribution and abundance of breeding salt marsh birds throughout New England. We will also use these coverages to determine salt marsh size, isolation, and level of human disturbance and to relate these parameters to salt marsh bird species distributions. In a companion study, the Maine Department of Inland Fisheries and Wildlife completed their three-year survey of coastal Maine. They will provide the data to complete the coverage of salt marsh habitats for all New England states.

Table 1. The number of tidal marshes and points surveyed within the four state region of the Salt Marsh Breeding Bird Survey, 1999.

State	County	Marshes	Points
Connecticut	New London	18	38
	Middlesex	13	31
	New Haven	41	64
	Fairfield	12	24
	TOTAL	84	157
Rhode Island	Washington	9	23
	Bristol	11	14
	Providence	1	1
	Newport	10	14
	Kent	3	3
	TOTAL	34	55
Massachusetts	Barnstable	22	55
	Essex	7	53
	TOTAL	29	108
New Hampshire	Rockingham	3	21
GRAND TOTAL		**150**	**661**

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2013

Wildlife Conservation and Alternative Land Uses at Airports

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11 Wildlife Conservation and Alternative Land Uses at Airports

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Given all the attention paid throughout this book to minimizing the risk of wildlife–aircraft strikes, the title of this chapter may seem like an oxymoron. This book has emphasized management as related to the hazardous (to aircraft) sector of biodiversity. In this chapter we focus on the issue of protection and management of less hazardous taxa, and how altering land use at airports might, in limited circumstances, contribute to this objective.

The term "conservation" often leads to confusion and perceived conflicting goals of management. In fact, many of the direct management techniques used at airports (e.g., deterrents, translocation, etc.) could be considered conservation measures, because they remove birds from harm's way. None of these techniques are designed to extirpate a species from the environment; they are employed to reduce or remove risk to aviation, as well as the birds themselves (Blokpoel 1976, Conover 2002). Even in cases where lethal population control is used, the species involved are typically common and not threatened with extinction. In the context of this chapter we define conservation as the "protection and management of biodiversity" (Groom et al. 2006).

Conservation biologists and other scientists have debated whether wildlife conservation, such as promoting grassland birds, is an appropriate objective for airports (Kelly and Allan 2006, Blackwell et al. 2013). However, there is a lack of scientific literature on this topic to provide the necessary guidance. The ambiguity of promoting conservation at airports exists because of numerous factors, including imperfect information about wildlife response to habitat management or altering land use, variation in human values for certain wildlife taxa, and spatial variations in wildlife resource needs. Research based on ecological and animal behavior principles is necessary to achieve a safe airport environment while having any hope for wildlife conservation (Blackwell et al. 2013). Nevertheless, wildlife management at airports must continue in the face of uncertainty. Our goal is to provide background information necessary to reduce ambiguity on this issue as well as a roadmap for consideration of future conservation and applied research efforts.

Current Land Use and Implications for Wildlife

The connections between land use, land cover, and wildlife habitat are at the forefront of conserving wildlife at airports (Blackwell et al. 2009). Land use can be defined as how and why humans employ the land and its resources (Meyer 1995, Turner et al. 2001). Land cover refers to the "vegetation type present such as forest, agriculture, and grassland" (Turner et al. 2001). We use Hall et al.'s (1997) definition of habitat as "the resources and conditions present in an area that produce occupancy—including survival and reproduction—by a given organism." In the context of the airport environment, most species' habitat requirements will not be met solely on airport property, requiring movements to and from the airport (which, incidentally, could increase strike risk; Chapter 12). The airport proper may be used for specific resource needs, such as food (Chapter 8). For some grassland species, however, seasonal habitat may exist only on airport property (Kershner and Bollinger 1996). Eastern meadowlarks (*Sturnella magna*) are grassland-obligate birds that forage and nest in grass-dominated areas (e.g., hayfields or mowed airport fields; Roseberry and Klimstra 1970), whereas European starlings (*Sturnus vulgaris*) are a facultative-grassland species that forage in grasslands but nest in cavities (Kessel 1957). Meadowlarks require only a single land use or cover type; starlings minimally require two land-use/cover types to fulfill their life history requirements. Not only does this simple example demonstrate the importance of terminology usage, but it has important implications for management. Control or conservation of meadowlarks could conceivably be achieved in a single grassland patch within the airport boundary. However, management of starlings to reduce use at the airport may require alterations of two land-use types—mowed fields and structures offering cavities—making the task more difficult.

Wildlife occupancy of various land-use/cover types can markedly influence the risk of wildlife collisions with aircraft. The International Civil Aviation Organization (2002) provides this summary of the effects of certain land uses on wildlife hazards:

> Land uses considered as contributing to wildlife hazards on or near [i.e., within 13 km] airports are fish-processing operations; agriculture; livestock feed lots; refuse dumps and landfills; factory roofs; parking lots; theaters and food outlets; wildlife refuges; artificial and natural lakes; golf and polo courses, etc.; animal farms; and slaughter houses.

In addition, the International Civil Aviation Organization grades land uses as to whether they are acceptable within radii from the airport center of 3 and 8 km (1.9 and 5 miles). The Federal Aviation Administration (2007) also provides guidance for hazardous attractants at or near airports. Other chapters in this book discuss land-use/cover types, including water resources (Chapter 9), turfgrass (a form of grassland; Chapter 10), and trash facilities (included in Chapter 8). These land-use/cover types can represent a substantial portion of the area surrounding airports; other land uses may include agriculture as well as alternative

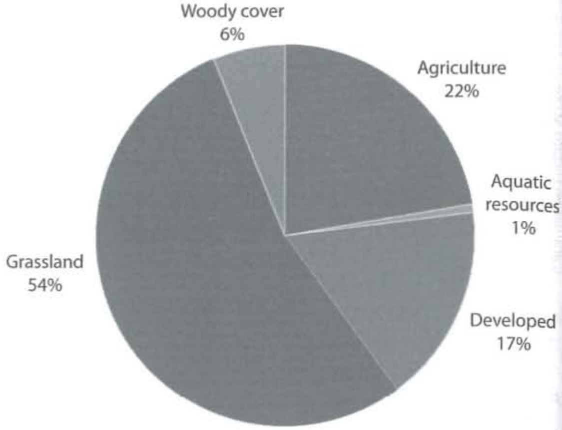


Fig. 11.1. Percentage of land cover or habitat type for 10 small airports in Indiana, USA. Adapted from DeVault et al. (2009)

energy crops and sources (DeVault et al. 2009, 2012). In this chapter we briefly discuss agriculture, including alternative energy crops, and its value for avian conservation and hazardous species reduction, as well as habitat needs of grassland birds.

Agriculture as a Land Use, Cover Type, and Habitat Component

As noted above, airports consist of a wide range of land cover and potential habitat types (Fahrig 2003, DeVault et al. 2009; Fig. 11.1). The degree to which habitat contributes to wildlife–aircraft strike risk at airports should not be based on the overall number of wildlife species that use the cover, however, but on the relative hazards those species pose to aircraft (DeVault et al. 2011). A land cover with greater wildlife abundance and diversity may actually represent a lower hazard to aircraft and might be more suitable for use at airports. Robertson et al. (2011) compared bird communities in three different land covers, including corn (*Zea mays*), switchgrass (*Panicum virgatum*), and prairie. The higher avian species richness in the prairie system (45 species; Fig. 11.2) might imply that prairies present a greater hazard to aircraft. However, when considering the relative hazard of the species found in the cover (Dolbeer et al. 2000, Dolbeer and Wright 2009, DeVault et al. 2011), corn had the greatest overall hazard to aviation (Fig. 11.2).

Federal Aviation Administration regulations dis-

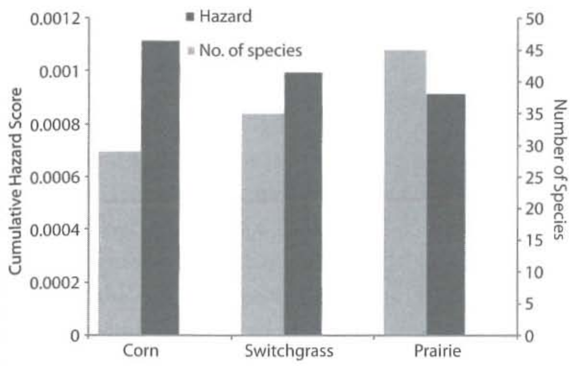


Fig. 11.2. Cumulative hazard and diversity of bird communities for three habitat types. Cumulative hazard scores were derived from relative hazard scores (Dolbeer and Wright 2009), were summed for each habitat type, and then scaled for interpretation. Lower values indicate less hazardous bird communities. Data adapted from Robertson et al. (2011)

courage the presence of "hazardous wildlife attractants," including all types of agriculture, at and near certificated U.S. airports (Federal Aviation Administration 2007, Blackwell et al. 2009). Even so, many U.S. airports lease portions of their land for agricultural production (Blackwell et al. 2009, DeVault et al. 2009), in part to reduce the economic burden of mowing turfgrass (Thomson 2007). These leased portions typically contain crops such as corn, wheat (*Triticum* spp.), and soybeans (*Glycine* spp.), which are wildlife attractants (Dolbeer et al. 1986, DeVault et al. 2007, Cerkal et al. 2009) even though they are notoriously depauperate, simplistic systems (Matson et al. 1997, Butler et al. 2007). If these systems lack diversity, then why are they not suited for airport use? These systems offer an important resource (i.e., food) for species that tend to be larger in size (e.g., white-tailed deer [*Odocoileus virginianus*]; Hein et al. 2012) and are most hazardous to aircraft (DeVault et al. 2011). But not all agriculture crops should be discounted categorically as a potential land cover for airports. Crops that lack palatable forage or abundant seed resources, such as some biofuel crops, may not attract hazardous wildlife, could potentially promote/protect some wildlife species of conservation concern, and provide some economic return. Empirical evidence is needed to determine which crops might fulfill these criteria at airports.

Herbaceous Cellulosic Feedstocks as a Potential Land Use at Airports

Crops under consideration for planting at airports include those that can be used to produce biofuel. Candidate crops for biofuel production range widely, from monocultures of exotic plants (e.g., *Miscanthus giganteus*; Heaton et al. 2008) to diverse native warm-season grass mixtures (Tilman et al. 2006, 2009; Somerville et al. 2010), although the use of nonherbaceous feedstocks may not be feasible within air operations areas (AOAs) because of safety concerns related to visibility (Austin-Smith and Lewis 1969). Existing grasslands at airports could potentially be managed for biofuel production if converted to appropriate herbaceous cellulosic feedstocks (Blackwell et al. 2009, DeVault et al. 2012). Switchgrass, for example, can yield 8.7–12.9 Mg/ha (19,180–28,440 lb/ha) of biomass depending on ecotype and management (McLaughlin and Kszos 2005, Adler et al. 2006, Mooney et al. 2008, Borsuk et al. 2010). Low-input, diverse native warm-season grass mixtures may produce even higher ethanol yields with greater greenhouse gas benefits than switchgrass monocultures (Tilman et al. 2006). The amount of grassland available at airports is much less than the area necessary to sustain a biofuel energy plant (Kocoloski et al. 2011), but airports could be integrated into an overall production and transportation strategy for biofuel production and thus could potentially contribute to this area of alternative energy production (DeVault et al. 2012).

Species composition of wildlife communities varies widely across different biofuel crops (Fargione et al. 2009, Meehan et al. 2010, Robertson et al. 2011). Field research is lacking on biofuel crops that, from an aviation perspective, would be compatible with safe airport operations, although research is ongoing (Blackwell et al. 2009, Martin et al. 2011, DeVault et al. 2012). We consider three possible land covers or grassland communities that might be feasible for the airport environment: switchgrass, *Miscanthus*, and a native prairie community (bluestems [*Andropogon* spp. and *Schizachyrium* spp.], Indiangrass [*Sorghastrum* spp.], and associated forbs).

Most research on herbaceous perennial grasslands for biofuels has been conducted on switchgrass (Murray and Best 2003, Murray et al. 2003, Roth et al. 2005;

Fig. 11.3. Switchgrass (*Panicum virgatum*) field planted for biomass production near West Point, Mississippi, USA. Photo credit: Tara Conkling

Fig. 11.3). But many of these studies were conducted on Conservation Reserve Program fields, which limit applicability to biofuel production at airports. Recent studies examining impacts of cellulosic biofuel crops on wildlife indicate that both *Miscanthus* and native grasses, including switchgrass and native warm-season grasses (as mentioned earlier), may provide benefits to some birds during winter and breeding seasons (Murray et al. 2003, Bellamy et al. 2009, Sage et al. 2010). The benefits of *Miscanthus* are temporary, however, without continuous wildlife management practices necessary to maintain the features of established plots that are attractive to birds (Bellamy et al. 2009). These features may be lost if plots are managed primarily to maximize biofuel production (Bellamy et al. 2009). There are additional questions regarding wildlife response to large plots of *Miscanthus* in the USA, as the vegetation structure is different from native grasslands, and it is unknown if avian species would perceive the bamboo-like vegetation as suitable habitat (Fargione et al. 2009).

Switchgrass and other native warm-season grasses may provide less ethanol output per unit area than *Miscanthus* (Heaton et al. 2008), but as native grass species, they might also be preferable as noninvasive wildlife habitat. Using switchgrass to convert existing row crop fields to biomass production provides new habitat for grassland birds (Murray et al. 2003), which could also reduce the presence of species typically attracted to crop fields (Dolbeer et al. 1986, DeVault et al. 2007). Roth et al. (2005) found that variation in the timing of switchgrass biofuel harvests and the resulting vegetation structure favored different grassland bird species, and a mosaic of harvest timings may increase local avian diversity. Recent research indicates that mixed-species grasslands with more diverse vegetation structures may provide even greater avian species richness and abundances than switchgrass (Robertson et al. 2011). T. J. Conkling et al. (unpublished data) have found prairie to be productive for breeding grassland birds such as dickcissels (*Spiza americana*), whereas switchgrass monoculture has demonstrated conservation value during winter months for species such as Le Conte's sparrow (*Ammodramus leconteii*). Preliminary results of studies in Mississippi investigating the hazard level of birds occupying switchgrass and prairie suggest these land covers may be suitable for airport grasslands in certain situations (T. J. Conkling et al., unpublished data).

Conservation of Birds

There are >3,300 km^2 (1,274 miles^2) of airport grasslands in the contiguous USA (DeVault et al. 2012).

Due to the amount of airport grasslands and because populations of grassland birds in North America are declining from habitat loss and degradation (Peterjohn and Sauer 1999, Askins et al. 2007), it has been suggested that airports may provide needed grassland habitat. However, airport grasslands pose challenges with respect to potential conservation efforts that must be recognized. We outline issues with habitat fragmentation, the role of airports as part of the general landscape, potential population losses of birds using airport grasslands, and the attraction of hazardous species to grasslands. Much of this section parallels the work of Blackwell et al. (2013).

Although the average airport in the contiguous USA contains 113 ha of turfgrass and other associated grassland cover types (DeVault et al. 2012), at many of these airports much of the grassland is scattered (i.e., fragmented) across a much larger area. Furthermore, some smaller airports do not contain grassland that extends appreciably beyond the AOA. The lack of large, unfragmented grassland tracts at some airports limits their value for grassland bird conservation. It is well established that habitat fragmentation negatively impacts abundance, distribution, and reproductive success of many grassland bird species, with declines more pronounced in area-sensitive species (Coppedge et al. 2001, Riffell et al. 2001, Chalfoun et al. 2002, Koper and Schmiegelow 2006, Ribic et al. 2009). Habitat fragmentation and the resulting loss of landscape connectivity is a major contributor to avian species declines and extinctions globally (Fischer and Lindenmayer 2007), yet patches as small as 50 ha may maximize bird species richness in a fragmented landscape (Helzer and Jelinski 1999), and small grassland patches with minimal edge habitat may also benefit grassland bird breeding and conservation (Davis and Brittingham 2004, Walk et al. 2010). Even so, research indicates that small grassland fragments cannot provide suitable habitat for bird species requiring large habitat patches (Johnson and Temple 1986, Vickery et al. 1995, Johnson and Igl 2001). Additionally, the shape of the habitat fragment and the distribution of fragments throughout the landscape can affect the settlement patterns of bird species (Laurance and Yensen 1991, Herkert 1994) or nest predation rates during the breeding season (Burger et al. 1994, Bergin et al. 2000, Grant et al. 2006). Therefore the habitat needs of the species of interest must be compared to the available size and shape of grassland areas at each airport.

Local- and landscape-scale influences ultimately drive grassland bird use for most species (Cunningham and Johnson 2006, Blackwell et al. 2009, Martin et al. 2011). When considering the potential for airports as suitable habitat for grassland birds, airports must be viewed in association with the surrounding habitat matrix. In areas with substantial grassland surrounding patches, for example, nest success may increase (Berman 2007). Keyel et al. (2011) found that species believed to be area-sensitive may also respond to habitat openness, rather than patch size. If airports can provide additional grassland habitat to supplement the existing matrix, avian species—especially those with less stringent area requirements—may increase their use of these patches.

Despite the best intentions of biologists, conservation practices created specifically for wildlife on or off airport properties could result in sink habitats for grassland birds (McCoy et al. 1999, Murphy 2001). Ecological traps (Schlaepfer et al. 2002, Battin 2004) are also possible if infrequently managed grassland areas are mown during the breeding season (Kershner and Bollinger 1996), or if area-sensitive species are attracted to habitat patches with a high edge-to-area ratio (Winter and Faaborg 1999, Johnson and Igl 2001, Davis and Brittingham 2004, Renfrew et al. 2005). Some researchers argue that impacts to grassland species of conservation concern can be limited by adjusting timing of mowing relative to a species' breeding season (Brennan and Kuvlesky 2005). Kershner and Bollinger (1996) noted that nest predation accounted for only 23% of nest failures at airports in Illinois, relative to 44% of nest failures resulting from mowing. By altering mowing and providing some nest predator control, it may be possible to reduce the sink potential of airport grasslands for birds. Still, Blackwell et al. (2013) note that, regardless of whether airport grasslands function as sink habitats (Murphy 2001) or provide connectivity between grassland patches, issues associated with the attraction of species known to pose strike hazards to aviation remain (see also Martin et al. 2011).

Most grassland bird species require mature grasslands at some point in their life cycle (Askins et al. 2007); such habitats generally harbor greater invertebrate and vertebrate species diversity and richness

(Gardiner et al. 2002), which could also enhance resources for species hazardous to aviation (Sodhi 2002). Because safety should be the first priority of all airports, any grassland management approach that attracts hazardous species (DeVault et al. 2011) should be altered to reduce the attraction of the area to these species. If that alteration results in the loss of habitat for grassland bird species of concern, alternative management plans should be explored.

Grassland areas within the AOA may be minimally useful for grassland birds due to habitat fragmentation, small patch size, losses from mowing, and because providing permanent habitat for obligate grassland species will likely conflict with management techniques needed to remove food resources or roosting sites for hazardous species (Blackwell et al. 2013). One scenario that could possibly enhance grassland bird conservation, however, would be for grassland conservation management to occur beyond the AOA and other airport-specific siting criteria (Blackwell et al. 2009, 2013). Such placement might allow specific management of nonhazardous species on and near airport lands without compromising air safety.

Conservation of Mammals

Mammals are often overlooked as a source of risk for aviation, which has direct implications for conservation management of most mammalian species at airports. Dolbeer and Wright (2009) reported that, since 1990, U.S civil aircraft struck 36 mammal species, including eight species of bats. Of these 36 species, 21 (including two bat species; Dolbeer and Wright 2009) caused damage to aircraft. Mammal species considered high to extremely high hazards to aircraft included mule deer (*O. hemionus*), white-tailed deer, domestic dog (*Canis familiaris*), and coyote (*C. latrans*; Biondi et al. 2011, DeVault et al. 2011). Other mammal species struck by aircraft include eastern cottontail (*Sylvilgaris floridanus*), raccoon (*Procyon lotor*), black-tailed jackrabbit (*Lepus californicus*), woodchuck (*Marmota monax*), opossum (*Didelphus virginianus*), striped skunk (*Mephitis mephitis*), and red fox (*Vulpes vulpes*; K. M. Biondi, unpublished data; Dolbeer and Wright 2009). In addition to their high hazard ranking, the most frequently struck mammals are deer and coyotes (Dolbeer and Wright 2009, Biondi et al. 2011, DeVault et al. 2011). Any management or land-use modifications should avoid promoting use by deer and canids.

Mammal species of conservation concern are typically associated with unmanaged systems and are mostly ill adapted to human-altered environments (Ceballos et al. 2005), making mammal conservation at airports unlikely overall. Small mammals adapted for grasslands such as shrews (Soridae), *Peromyscus* spp., and other Muridae species—including cotton rats (*Sigmodon hispidus*) and jumping mice (*Zapus* spp.; Hall and Willig 1994, Kaufman et al. 1997)—may be attracted to airport grasslands. However, increased populations of these species at airports should generally be avoided, as both avian and mammalian predators of small mammals are typically large in size and hazardous to aircraft. Under simplistic models and assumptions, increased small-mammal diversity and biomass might cause functional and abundance shifts in predators (Holling 1965, Korpimäki and Norrdahl 1991, Korpimäki and Krebs 1996). Direct management of these predators may be possible, but the trade-off in conservation value, increased risk to aviation, and management cost would likely preclude targeted mammalian conservation at airports.

Summary

Conservation of wildlife species on airports, although problematic, may be best achieved through altering current land covers from traditional turfgrass management. Possible alternatives include prairie grass and switchgrass systems managed for forage or biofuels (DeVault et al. 2012). These options could, in some circumstances, conserve wildlife directly by providing in situ habitat for grassland birds (away from the AOA) or, perhaps more feasibly, indirectly by reducing the global carbon footprint (Tilman et al. 2009). Regardless, all alternative habitats at airports should be considered in the context of landscape fragmentation, metapopulation dynamics, and edge effects as they relate to grassland birds. Mammal conservation is not likely feasible at airports on any measurable scale. Most importantly, we encourage managers interested in wildlife conservation at airports to consider carefully how management of various grasslands systems might promote occupancy by hazardous species. Wildlife conservation will likely occur only past airport-specific siting criteria (Federal Aviation Administration 2007) to minimize risk to aviation (Blackwell et al. 2009, 2013). Potential economic benefits of alternative energy sources may contribute to adoption of biofuel grasslands on airports, but more research is needed.

LITERATURE CITED

Adler, P. R., M. A. Sanderson, A. A. Boateng, P. J. Weimer, and H. J. G. Jung. 2006. Biomass yield and biofuel quality of switchgrass harvested in fall or spring. Agronomy Journal 98:15–18.

Askins, R. A., F. Chavez-Ramirez, B. C. Dale, C. A. Haas, J. R. Herkert, F. L. Knopf, and P. D. Vickery. 2007. Conservation of grassland birds in North America: understanding ecological processes in different regions. Report of the AOU Committee on Conservation. Ornithological Monographs 64:1–46.

Austin-Smith, P. J., and H. F. Lewis. 1969. Alternative vegetative ground cover. Pages 153–160 *in* Proceedings of the world conference on bird hazards to aircraft, 2–5 September 1969. National Research Council of Canada, Kingston, Ontario, Canada.

Battin, J. 2004. When good animals love bad habitats: ecological traps and the conservation of animal populations. Conservation Biology 18:1482–1491.

Bellamy, P. E., P. J. Croxton, M. S. Heard, S. A. Hinsley, L. Hulmes, S. Hulmes, P. Nuttall, R. F. Pywell, and P. Rothery. 2009. The impact of growing *Miscanthus* for biomass on farmland bird populations. Biomass and Bioenergy 33:191–199.

Bergin, T. M., L. B. Best, K. E. Freemark, and K. J. Koehler. 2000. Effects of landscape structure on nest predation in roadsides of a midwestern agroecosystem: a multiscale analysis. Landscape Ecology 15:131–143.

Berman, G. M. 2007. Nesting success of grassland birds in fragmented and unfragmented landscapes of north central South Dakota. Thesis, South Dakota State University, Brookings, USA.

Biondi, K. M., J. L. Belant, J. A. Martin, T. L. DeVault, and G. Wang. 2011. White-tailed deer incidents with U.S. civil aircraft. Wildlife Society Bulletin 35:303–309.

Blackwell, B. F., T. L. DeVault, E. Fernández-Juricic, and R. A. Dolbeer. 2009. Wildlife collisions with aircraft: a missing component of land-use planning for airports. Landscape and Urban Planning 93:1–9.

Blackwell, B. F., T. W. Seamans, P. M. Schmidt, T. L. DeVault, J. L. Belant, M. J. Whittingham, J. A. Martin, and E. Fernández-Juricic. 2013. A framework for managing airport grasslands and birds amidst conflicting priorities. Ibis 155:199–203.

Blokpoel, H. 1976. Bird hazards to aircraft: problems and prevention of bird/aircraft collisions. Clarke, Irwin, Ottawa, Ontario, Canada.

Borsuk, M. E., S. D. Wullschleger, E. B. Davis, L. R. Lynd, and C. A. Gunderson. 2010. Biomass production in switchgrass across the United States: database description and determinants of yield. Agronomy Journal 102:1158–1168.

Brennan, L. A., and W. P. Kuvlesky. 2005. North American grassland birds: an unfolding conservation crisis? Journal of Wildlife Management 69:1–13.

Burger, L. D., J. Burger, and J. Faaborg. 1994. Effects of prairie fragmentation on predation on artificial nests. Journal of Wildlife Management 58:249–254.

Butler, S. J., J. A. Vickery, and K. Norris. 2007. Farmland biodiversity and the footprint of agriculture. Science 315:381–384.

Ceballos, G., P. R. Ehrlich, J. Soberón, I. Salazar, and J. P. Fay. 2005. Global mammal conservation: what must we manage? Science 309:603–607.

Cerkal, R., K. Vejrazka, J. Kamler, and J. Dvorak. 2009. Game browse and its impact on selected grain crops. Plant Soil Environment 55:181–186.

Chalfoun, A. D., F. R. Thompson III, and M. J. Ratnaswamy. 2002. Nest predators and fragmentation: a review and meta-analysis. Conservation Biology 16:306–318.

Conover, M. R. 2002. Resolving human–wildlife conflicts: the science of wildlife damage management. CRC Press, Boca Raton, Florida, USA.

Coppedge, B. R., D. M. Engle, R. E. Masters, and M. S. Gregory. 2001. Avian response to landscape change in fragmented southern Great Plains grasslands. Ecological Applications 11:47–59.

Cunningham, M. A., and D. H. Johnson. 2006. Proximate and landscape factors influence grassland bird distributions. Ecological Applications 16:1062–1075.

Davis, S. K., and M. Brittingham. 2004. Area sensitivity in grassland passerines: effects of patch size, patch shape, and vegetation structure on bird abundance and occurrence in southern Saskatchewan. Auk 121:1130–1145.

DeVault, T. L., J. C. Beasley, L. A. Humberg, B. J. MacGowan, M. I. Retamosa, and O. E. Rhodes Jr. 2007. Intrafield patterns of wildlife damage to corn and soybeans in northern Indiana. Human–Wildlife Conflicts 1:205–213.

DeVault, T. L., J. L. Belant, B. F. Blackwell, J. A. Martin, J. A. Schmidt, L. W. Burger, and J. W. Patterson. 2012. Airports offer unrealized potential for alternative energy production. Environmental Management 49:517–522.

DeVault, T. L., J. L. Belant, B. F. Blackwell, and T. W. Seamans. 2011. Interspecific variation in wildlife hazards to aircraft: implications for airport wildlife management. Wildlife Society Bulletin 35:394–402.

DeVault, T. L., J. E. Kubel, O. E. Rhodes Jr., and R. A. Dolbeer 2009. Habitat and bird communities at small airports in the midwestern USA. Proceedings of the Wildlife Damage Management Conference 13:137–145.

Dolbeer, R. A., P. P. Woronecki, and R. L. Bruggers. 1986. Reflecting tapes repel blackbirds from millet, sunflowers, and sweet corn. Wildlife Society Bulletin 14:418–425.

Dolbeer, R. A., and S. E. Wright. 2009. Safety management systems: how useful will the FAA National Wildlife Strike Database be? Human–Wildlife Conflicts 3:167–178.

Dolbeer, R. A., S. E. Wright, and E. C. Cleary. 2000. Ranking the hazard level of wildlife species to aviation. Wildlife Society Bulletin 28:372–378.

Fahrig, L. 2003. Effects of habitat fragmentation on biodiversity. Annual Review of Ecology, Evolution, and Systematics 34:487–515.

Fargione, J. E., T. R. Cooper, D. J. Flaspohler, J. Hill, C. Lehman, T. McCoy, S. McLeod, E. J. Nelson, K. S. Oberhauser, and D. Tilman. 2009. Bioenergy and wildlife: threats and opportunities for grassland conservation. Bioscience 59:767–777.

Federal Aviation Administration. 2007. Hazardous wildlife attractants on or near airports. Advisory Circular 150/5200-33B. U.S. Department of Transportation, Washington, D.C., USA.

Fischer, J., and D. B. Lindenmayer. 2007. Landscape modification and habitat fragmentation: a synthesis. Global Ecology and Biogeography 16:265–280.

Gardiner, T., M. Pye, R. Field, and J. Hill. 2002. The influence of sward height and vegetation composition in determining the habitat preferences of three Chorthippus species (Orthoptera: Acrididae) in Chelmsford, Essex, UK. Journal of Orthoptera Research 11:207–213.

Grant, T. A., E. M. Madden, T. L. Shaffer, P. J. Pietz, G. B. Berkey, and N. J. Kadrmas. 2006. Nest survival of clay-colored and vesper sparrows in relation to woodland edge in mixed-grass prairies. Journal of Wildlife Management 70:691–701.

Groom, M. J., G. K. Meffe, and C. R. Carroll. 2006. Principles of conservation biology. Sinauer, Sunderland, Massachusetts, USA.

Hall, D. L., and M. R. Willig. 1994. Mammalian species composition, diversity, and succession in conservation reserve program grasslands. Southwestern Naturalist 39:1–10.

Hall, L. S., P. R. Krausman, and M. L. Morrison. 1997. The habitat concept and a plea for standard terminology. Wildlife Society Bulletin 25:173–182.

Heaton, E. A., F. G. Dohleman, and S. P. Long. 2008. Meeting US biofuel goals with less land: the potential of *Miscanthus*. Global Change Biology 14:2000–2014.

Hein, A. M., C. Hou, and J. F. Gillooly. 2012. Energetic and biomechanical constraints on animal migration distance. Ecology Letters 15:104–110.

Helzer, C. J., and D. E. Jelinski. 1999. The relative importance of patch area and perimeter-area ratio to grassland breeding birds. Ecological Applications 9:1448–1458.

Herkert, J. R. 1994. The effects of habitat fragmentation on midwestern grassland bird communities. Ecological Applications 4:461–471.

Holling, C. S. 1965. The functional response of predators to prey density and its role in mimicry and population regulation. Memoirs of the Entomological Society of Canada 97:1–60.

International Civil Aviation Organization. 2002. Land use and environmental control. Airport Planning Manual 9184 AN/902, Part 2. Montreal, Quebec, Canada.

Johnson, D. H., and L. D. Igl. 2001. Area requirements for grasslands birds: a regional perspective. Auk 118:24–34.

Johnson, R. G., and S. A. Temple. 1986. Assessing habitat quality for birds nesting in fragmented tallgrass prairies. Pages 245–249 *in* J. Verner, M. L. Morrison, and C. J. Ralph, editors. Wildlife 2000: modeling habitat relationships of terrestrial vertebrates. University of Wisconsin Press, Madison, USA.

Kaufman, G. A., D. W. Kaufman, F. L. Knopf, and F. B. Samson. 1997. Ecology of small mammals in prairie landscapes. Pages 207–243 *in* F. L. Knopf and F. B. Samson, editors. Ecology and conservation of Great Plains vertebrates. Springer, New York, New York, USA.

Kelly, T., and J. Allan. 2006. Ecological effects of aviation. The ecology of transportation: managing mobility for the environment. Environmental Pollution 10:5–24.

Kershner, E. L., and E. K. Bollinger. 1996. Reproductive success of grassland birds at east-central Illinois airports. American Midland Naturalist 136:358–366.

Kessel, B. 1957. A study of the breeding biology of the European starling (*Sturnus vulgaris* L.) in North America. American Midland Naturalist 58:257–331.

Keyel, A. C., C. M. Bauer, C. R. Lattin, L. M. Romero, and J. M. Reed. 2011. Testing the role of patch openness as a causal mechanism for apparent area sensitivity in a grassland specialist. Oecologia 169:1–12.

Kocoloski, M., W. M. Griffin, and H. S. Matthews. 2011. Impacts of facility size and location decisions on ethanol production cost. Energy Policy 39:47–56.

Koper, N., and F. K. K. Schmiegelow. 2006. A multi-scaled analysis of avian response to habitat amount and fragmentation in the Canadian dry mixed-grass prairie. Landscape Ecology 21:1045–1059.

Korpimäki, E., and C. J. Krebs. 1996. Predation and population cycles of small mammals. BioScience 46:754–764.

Korpimäki, E., and K. Norrdahl. 1991. Numerical and functional responses of kestrels, short-eared owls, and long-eared owls to vole densities. Ecology 72:814–826.

Laurance, W. F., and E. Yensen. 1991. Predicting the impacts of edge effects in fragmented habitats. Biological Conservation 55:77–92.

Martin, J. A., J. L. Belant, T. L. DeVault, B. F. Blackwell, L. W. Burger Jr., S. K. Riffell, and G. Wang. 2011. Wildlife risk to aviation: a multi-scale issue requires a multi-scale solution. Human–Wildlife Interactions 5:198–203.

Matson, P. A., W. J. Parton, A. G. Power, and M. J. Swift. 1997. Agricultural intensification and ecosystem properties. Science 277:504–509.

McCoy, T. D., M. R. Ryan, E. W. Kurzejeski, and L. W. Burger Jr. 1999. Conservation Reserve Program: source or sink habitat for grassland birds in Missouri? Journal of Wildlife Management 63:530–538.

McLaughlin, S. B., and L. A. Kszos. 2005. Development of switchgrass (*Panicum virgatum*) as a bioenergy feedstock in the United States. Biomass and Bioenergy 28:515–535.

Meehan, T. D., A. H. Hurlbert, and C. Gratton. 2010. Bird communities in future bioenergy landscapes of the Upper Midwest. Proceedings of the National Academy of Sciences of the United States of America 107:18,533–18,538.

Meyer, W. B. 1995. Past and present land use and land cover in the USA. Consequences 1:25–33.

Mooney, D. F., R. K. Roberts, B. C. English, D. D. Tyler, and J. A. Larson. 2008. Switchgrass production in marginal environments: a comparative economic analysis across four west Tennessee landscapes. Proceedings of the 2008 annual meeting. Agricultural and Applied Economics Association, 27–29 July 2008, Orlando, Florida, USA.

Murphy, M. T. 2001. Source–sink dynamics of a declining eastern kingbird population and the value of sink habitats. Conservation Biology 15:737–748.

Murray, L. D., and L. B. Best. 2003. Short-term bird response to harvesting switchgrass for biomass in Iowa. Journal of Wildlife Management 67:611–621.

Murray, L. D., L. B. Best, T. J. Jacobsen, and M. L. Braster. 2003. Potential effects on grassland birds of converting marginal cropland to switchgrass biomass production. Biomass and Bioenergy 25:167–175.

Peterjohn, B. G., and J. R. Sauer. 1999. Population status of North American grassland birds from the North American breeding bird survey, 1966–1996. Studies in Avian Biology 19:27–44.

Renfrew, R. B., C. A. Ribic, and J. L. Nack. 2005. Edge avoidance by nesting grassland birds: a futile strategy in a fragmented landscape. Auk 122:618–636.

Ribic, C. A., R. R. Koford, J. R. Herkert, D. H. Johnson, N. D. Niemuth, D. E. Naugle, K. K. Bakker, D. W. Sample, and R. B. Renfrew. 2009. Area sensitivity in North American grassland birds: patterns and processes. Auk 126:233–244.

Riffell, S. K., B. E. Keas, and T. M. Burton. 2001. Area and habitat relationships of birds in Great Lakes coastal wet meadows. Wetlands 21:492–507.

Robertson, B. A., P. J. Doran, L. R. Loomis, J. R. Robertson, and D. W. Schemske. 2011. Perennial biomass feedstocks enhance avian diversity. GCB Bioenergy 3:235–246.

Roseberry, J. L., and W. D. Klimstra. 1970. The nesting ecology and reproductive performance of the Eastern Meadowlark. Wilson Bulletin 82:243–267.

Roth, A. M., D. W. Sample, C. A. Ribic, L. Paine, D. J. Undersander, and G. A. Bartelt. 2005. Grassland bird response to harvesting switchgrass as a biomass energy crop. Biomass and Bioenergy 28:490–498.

Sage, R., M. Cunningham, A. J. Haughton, M. D. Mallot, D. A. Bohan, A. Riche, and A. Karp. 2010. The environmental impacts of biomass crops: use by birds of *Miscanthus* in summer and winter in southwestern England. Ibis 152:487–499.

Schlaepfer, M. A., M. C. Runge, and P. W. Sherman. 2002. Ecological and evolutionary traps. Trends in Ecology and Evolution 17:474–480.

Sodhi, N. S. 2002. Competition in the air: birds versus aircraft. Auk 119:587–595.

Somerville, C., H. Youngs, C. Taylor, S. C. Davis, and S. P. Long. 2010. Feedstocks for lignocellulosic biofuels. Science 329:790–792.

Thomson, B. 2007. A cost effective grassland management strategy to reduce the number of bird strikes at the Brisbane airport. Thesis, Queensland University of Technology, Brisbane, Australia.

Tilman, D., J. Hill, and C. Lehman. 2006. Carbon-negative biofuels from low-input high-diversity grassland biomass. Science 314:1598–1600.

Tilman, D., R. Socolow, J. A. Foley, J. Hill, E. Larson, L. Lynd, S. Pacala, J. Reilly, T. Searchinger, C. Somerville, and R. Williams. 2009. Beneficial biofuels—the food, energy, and environment trilemma. Science 325:270–271.

Turner, M. G., R. H. Gardner, and R. V. O'Neill. 2001. Landscape ecology in theory and practice: pattern and process. Springer-Verlag, New York, New York, USA.

Vickery, P. C., M. L. Hunter, and S. M. Melvin. 1995. Effects of habitat area on the distribution of grassland birds in Maine. Conservation Biology 8:1087–1097.

Walk, J. W., E. L. Kershner, T. J. Benson, and R. E. Warner. 2010. Nesting success of grassland birds in small patches in an agricultural landscape. Auk 127:328–334.

Winter, M., and J. Faaborg. 1999. Patterns of area sensitivity in grassland-nesting birds. Conservation Biology 13:1424–1436.

Grasshopper Sparrow

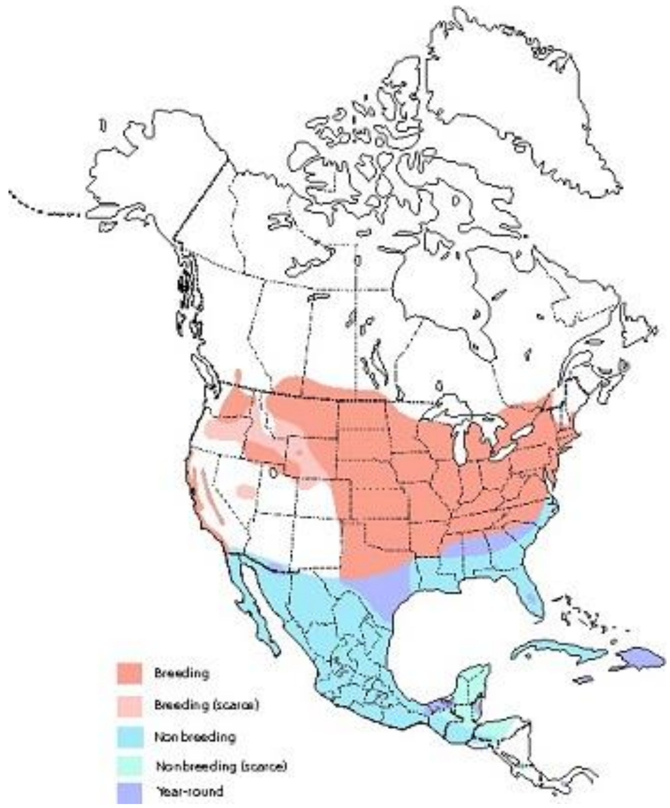
©Jeff Nadler Photography

Scientific name: *Ammodramus savannarum*

New York Status: **Special Concern**
Federal Status: Not Listed

Description

The grasshopper sparrow gets its name not so much from its diet but from its song which is one or two chips followed by a buzzy insect-like trill. This secretive grassland sparrow is more often heard than seen and remains hidden in dense grass cover. It perches on vegetative stalk or shrub while singing. It is a small, stocky sparrow (4-5.5 inches) with a flat head, relatively large bill, and white eye ring. Sexes are similar with gray to brown coloring above, buff colored sides and breast, and a short tail. The dark crown has a pale to white stripe down the center. It is the only grassland sparrow that lacks wing bars and streaking on its breast or sides although the juvenile shows these markings. This species forages for insects while walking or running along the ground.



Grasshopper sparrow range map from ***The Birds of North America****, maintained by the Cornell Lab of Ornithology.*

Life History

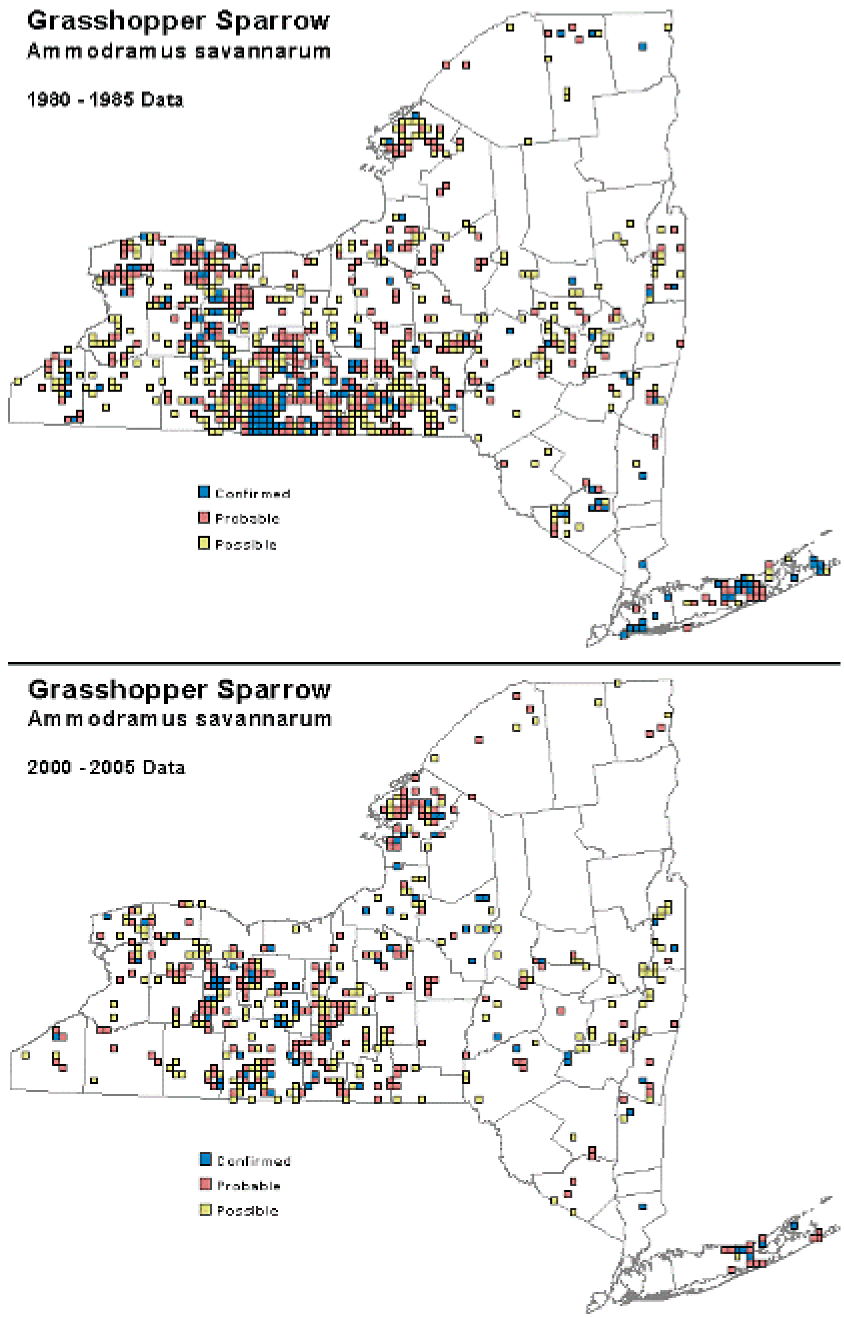
A late-spring migrant, the grasshopper sparrow returns to breeding grounds in the northeastern states in mid to late May. Because it is a nocturnal migrant, it is rarely seen during migration. Males arrive on breeding grounds 3 to 5 days before females. Once females arrive, pair bonds form and nest construction by the female begins immediately. The nest is built on the ground at the base of a clump of vegetation and consists of a deep cup of stems and grasses with over-hanging vegetation creating a dome with a side entrance. Pairs will raise 2 to 3 broods per year and will construct a new nest each time. Incubation is carried out by the female while the male defends the nest from predators and the territory from intruders.

Parents will not fly directly to or from the nest but walk along the ground when leaving or arriving. Clutch size is 3 to 6 eggs for the first brood with subsequent broods having fewer eggs. Nestlings hatch after 10 to 12 days and are cared for by both parents as well as non-parent females. Young leave the nest after 9 to 10 days but are unable to fly. They run or walk along the ground in dense cover to avoid disturbance. Young of the first brood will leave their natal territories once adults begin feeding nestlings of the second brood.

Distribution and Habitat

A common local breeder throughout much of the United States and southern Canada. Breeding range extends from southern Maine and New England south to northern Georgia, west to Texas and north to Montana, Idaho, and eastern Washington. The grasshopper sparrow depends on dense grasses for foraging and nesting cover. In New York it remains locally common where grassland habitat is available. Upland meadows, pastures, hayfields, and croplands are primary habitats for the grasshopper sparrow.

Status



Distribution of grasshopper sparrow in New York from 1st and 2nd NYS Breeding Bird Atlas records.

In the eastern United States, the historic distribution of the grasshopper sparrow was restricted to natural grasslands resulting from fires or flooding. The growth of agriculture in the late 19th and early 20th centuries created more breeding habitat and facilitated the spread of the grasshopper sparrow's range in the northeast. By the mid 1900s, however, loss of lands used for agriculture paired with the growth of development began to take its toll on grasshopper sparrow populations. In New York populations have declined considerably with the loss of grassland and agricultural habitat due to suburban land development and natural plant succession.

Management and Research Needs

Threats to the grasshopper sparrow population in New York include loss of nests due to mowing of fields during the nesting season, the use of pesticides by farmers, and the loss of grassland habitat resulting from development or plant succession. Management practices for preserving and restoring grasshopper sparrow habitat include prescribed burning and mowing and grazing of grasslands and agricultural areas. Management practices at airports have been successful where mowing is postponed until the end of the breeding season. Further research is needed on the winter ecology, distribution, and habitat use of migratory populations.

Northern Long-eared Bat

Scientific Name: ***Myotis septentrionalis***

New York Status: **Threatened**
Federal Status: **Threatened**

Distribution and Habitat

A northern long-eared bat in its hibernaculum.

Northern long-eared bats (NLEB), also known as Northern myotis, are primarily forest-dependent insectivores. They utilize a diversity of forest habitats for roosting, foraging and raising young. In general, any tree large enough to have a cavity or that has loose bark may be utilized by NLEB for roosting or rearing young. Prior to 2006, NLEB were frequently detected in the forests of every county of New York State with the exception of the 5 counties of New York City. Since they feed predominantly on flying insects, they hibernate through the late fall and early spring to save energy when food is not available. Most known hibernation sites are caves or abandoned mines.

A Species in Decline

NLEB were listed as "threatened" by the United States Fish and Wildlife Service (USFWS) under the federal Endangered Species Act on April 2, 2015. In New York, all federally threatened species that occur in the state are afforded threatened status under the New York Endangered Species Law and its implementing regulations. As recently as 2005, the NLEB was New York State's third most common bat species with populations estimated at or above 500,000 animals. The federal listing was the result of a dramatic population decline throughout most of the species' range. These declines have been caused by white-nose syndrome (WNS), a disease caused by an invasive fungus that ultimately causes affected hibernating bats to starve to death over the winter. Since WNS was first discovered in New York in 2006, a 98% decline in the abundance of NLEB has been observed. Successful recovery of the species will require the development of some form of treatment for exposure to WNS, and the DEC is actively working with researchers from around North America to develop a treatment. In the meantime, legal protections afforded by the listing status of the bat are focused on minimizing and avoiding direct loss of the remaining individuals by protecting the known hibernation sites and limiting forest management activities where NLEB are most likely to be present to certain times of the year.

General Recommendations for the Protection of Northern Long-eared Bats in New York

This section provides guidance regarding recommended measures to ensure that forest management activities are protective of the northern long-eared bat (NLEB) and do not result in an incidental take pursuant to 6NYCRR Part 182.

Guidance from DEC

Because it is the disease (WNS) and not habitat that is currently limiting the population, removal of trees from the landscape is not considered harmful unless there are potentially bats within the trees during the time they are harvested or otherwise removed from the landscape. We do not have perfect information on where NLEB occur. To protect NLEB from unintentional harm, the Department encourages the voluntary implementation of all forest management activities during the hibernation period **(November 1 through April 1)** when bats are not expected to be present. However, there are no restrictions on tree cutting unless a project is located within 5 miles of a known hibernation site or 1.5 miles of a documented summer occurrence. See the Protection of Northern Long-eared Bats page for a map and list of known NLEB occurrences by town. For all projects that require the removal of trees, the following voluntary actions are recommended:

- Leave snag and cavity trees uncut unless their removal is necessary for protection of human life and property. Snag and cavity trees are defined under DEC Program Policy ONR-DLF-2 Retention on State Forests.
- If any bats are observed flying from a tree, or on a tree that has been cut, tree management activities in the area should be suspended and DEC Wildlife staff notified as soon as possible. A permit may be required to continue work, or you may have to wait until November 1 to resume activities.

If your project is located within 5 miles of a known hibernation site or 1.5 miles of a documented summer occurrence, please see Protection of Northern Long-eared Bats for additional guidance.

For more information on other species of bats, visit Watchable Wildlife.

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February 1, 2017

Hon. Sean Walter – Supervisor
Town of Riverhead Long Island
200 Howell Avenue
Riverhead, N.Y. 11901

Dear Hon. Supervisor Walter:

As discussed at our meeting approximately two years ago, I funded a study on the endangered Eastern Tiger Salamanders on Long Island (Focus: Calverton) Enclosed is a copy of the completed research report. We would like to make a presentation, at your convenience, and will schedule a meeting with you within the next few months.

Thank you for your consideration.

Sincerely,

Andrew E. Sabin
AES/rr

Enclosure

Cc: Councilman John Dunleavy
Councilwoman Jodi Giglio
Councilman Tim Hubbard
Councilman James Wooten

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Population Genomics of Endangered Tiger Salamanders (*Ambystoma tigrinum*) on Long Island, NY Reveals a Highly Structured Species Impacted by Major Roads

Evan McCartney-Melstad[1*], Jannet Vu[1,2], H. Bradley Shaffer[1]

1: Department of Ecology and Evolutionary Biology, La Kretz Center for California Conservation Science, and Institute of Environmental Studies, University of California, Los Angeles
2: Department of Ecology and Evolutionary Biology, Stony Brook University, New York

Abstract

We used DNA sequence data from thousands of nuclear loci to characterize the population structure of endangered tiger salamanders (*Ambystoma tigrinum*) on Long Island and quantify the impacts of human development on this species. We uncovered highly genetically structured populations over an extremely small spatial scale (approximately 40 km^2) in an increasingly human-modified landscape. Geographic distance and the presence of major roads between ponds are both strong predictors of genetic divergence in this system, which suggests both natural and anthropogenic factors are responsible for the observed patterns of genetic variation. This study demonstrates the added value of genomic approaches in molecular ecology, as these patterns were not apparent in an earlier study of the same system using microsatellite loci. Ponds exhibited small effective population sizes, and there is a strong correlation between pond surface area and salamander population size. When combined with the high degree of structuring in this heavily modified landscape, our study suggests that these endangered amphibians require management at the individual pond, or pond cluster, landscape level. Particular efforts should be made to preserve large vernal pools, which harbor greater genetic diversity, and their surrounding upland habitat. Contiguous upland landscapes between ponds that encourage natural metapopulation dynamics and demographic rescue from future local extirpations should also be protected.

Introduction

Genetic, and, increasingly, genomic analyses constitute a powerful tool kit for understanding how species move through landscapes, particularly for secretive species such as reptiles and amphibians (Shaffer *et al.* 2015). When studying endangered species, we are often concerned with the degree to which human activity has impacted the size and movement of populations. This human interference often occurs at very small spatial scales compared to species range sizes—for example, building a road between two nearby populations that exchange migrants regularly—as well as short temporal scales, given that humans often have been impacting wildlife populations for tens or hundreds of generations. As conservation and resource managers and as population biologists, we are often less interested in larger scale effects across thousands of kilometers of a species range than we are about dynamics across a few kilometers on specific landscapes. This is especially true for low-vagility species like amphibians, reptiles, small mammals, and many invertebrates that often move a kilometer or less per generation (Blaustein *et al.* 1994). For such taxa, the genetic relationships between distant populations are often a result of ancient demographic processes, but interruption of gene flow at an extremely fine spatial scale is the defining component of human impacts. For protected or endangered species, understanding the extent to which human activities at the finest spatial scales alter demographic and population processes is the key to effective management.

Discerning gene flow and differentiation at very fine spatial scales is challenging because populations located proximately to one another tend to be very closely related (Wright 1943). Furthermore, the ability to detect differentiation between genetically very closely related populations is limited by the number of samples and genetic loci assayed (Patterson *et al.* 2006). Until now, nearly all population genetic studies of amphibians have been limited to mitochondrial DNA or a small number of nuclear loci (typically microsatellites). This is due at least in part to the large, highly repetitive genomes of many amphibians that make it difficult to generate genomic resources (Licht & Lowcock 1991; Sun *et al.* 2012). While this is slowly changing as genomic technologies are beginning to be being applied to amphibians (Keinath *et al.* 2016; McCartney-Melstad *et al.* 2016; Portik *et al.* 2016; Newman & Austin 2016), most systems that could benefit from genomic scale data remain unexplored. Custom target enrichment assays built from transcriptomic resources are promising intermediate solutions that bridge the gap between microsatellites and whole genome sequencing while allowing for flexibility in which genomic regions to study (McCartney-Melstad *et al.* 2016; Portik *et al.* 2016).

One interesting case study where the added resolution of genomic-scale datasets may make a difference is for tiger salamanders (*Ambystoma tigrinum*) on Long Island, a New York-listed endangered species (6 CRR-NY 182.5) where fine-scale population dynamics are critical for management decision making. *A. tigrinum* was historically found in scattered localities across New York at the northern limits of its range in the eastern US, including Albany County, Rockland County, and across Long Island. However, the species has experienced dramatic declines in the region, and it is currently restricted to Suffolk and Nassau Counties, primarily in central Long Island (Bishop 1941; Stewart & Rossi 1981). In recent years, surveyors have witnessed a decrease in the observed number of individuals, with approximately 90 breeding ponds remaining (New York State Department of Environmental Conservation 2015).

The species suffers a range of threats including disease, predation, pollution, invasive species, and climate change-induced sea level rise. Development is not only a source of habitat loss, but also creates direct mortality risk from road kill, degrades pond viability from pollutants, and creates barriers to migration and population fragmentation (Titus *et al.* 2014). Telemetry studies have documented individuals traveling at least 500 meters from breeding ponds, and confirmed that individuals tend to avoid paved roads, dirt roads, and grassy areas (Madison & Farrand 1998). Movements, which are often studied during the annual breeding migration, are generally oriented towards upland refugia in their preferred habitat of sandy soil, pine barren habitat (Madison & Farrand 1998; Titus *et al.* 2014).

Prior genetic work using twelve microsatellite loci recovered two distinct populations of *A. tigrinum* across 17 ponds spanning 50 km on Long Island, both of which exhibited low diversity and high relatedness among ponds (Titus *et al.* 2014). The authors attributed the low diversity and high relatedness to post-glacial colonization from North Carolina (Church *et al.* 2003) and relatively frequent migration of salamanders between ponds. Their primary conclusion was that Long Island and New Jersey tiger salamanders were genetically uniform within each state, but were differentiated between states due to geographic isolation and range fragmentation.

Most of the ponds analyzed by Titus *et al.* (2014) on Long Island were fewer than six kilometers apart, and their analyses and conclusions required genetic markers capable of discerning fine scale ecological processes. However, the microsatellite loci used showed relatively low diversity (1-13 alleles per locus across ponds and an average of 1-3 alleles per locus within ponds), and therefore were not the most imformative (Reyes-Valdés 2013). This leaves open the real possibility that these markers lacked the statistical power to detect real patterns of landscape-driven differentiation. This was not a fault of the Titus *et al.* (2014) work, but rather a reflection of the tools available when their work was undertaken.

To explore recent anthropogenic impacts on this endangered, fragmented set of populations further, we applied a genomic target capture approach with 5,237 random nuclear exons to ponds in the same system to quantify the degree to which ponds are isolated from one another and whether or not major roads act as barriers to dispersal for extant populations of *Ambystoma tigrinum* on Long Island. We sought to answer three separate questions: 1) To what degree are ponds genetically connected to or differentiated from one another?, 2) what are the effective population sizes of ponds in the system, are they related to pond area, and how do these values compare to other amphibians?, and 3) what are the effects of roads on connectivity between ponds in the system? The increased resolution recovered from the genomic dataset collected here demonstrates the increased power and utility of genomic-scale data for population genetics of threatened species, and highlights the fundamentally different conclusions for appropriate management interventions that such data can provide.

Methods

Sampling and Data Generation

Larval tissue samples were collected in Suffolk County over three consecutive breeding seasons between 2013 and 2015 using seines and dipnets. We timed our sampling to occur in the late spring when larvae were large enough to sample non-destructively with small tail clips (Polich *et al.* 2013). Tail tips were placed in 95% ethanol within 30 seconds of clipping, larvae were immediately released at the site of capture, and tail tips were stored at -80C until use. A hand-held GPS unit was used to locate ponds in the field, and final spatial coordinates and areas of ponds were taken from tracings of Google Earth images from March 2007. We sampled larvae from multiple sites at each pond to randomly sample the genetic variation present. DNA was extracted from samples using a salt extraction protocol (Sambrook & Russell 2001), diluted to 100 ng/μL, and sheared for 28 cycles (30s on, 90s off) using the "high" setting on a Bioruptor NGS (Diagenode). After shearing, samples were dual-end size selected to approximately 300-500bp using 0.8X-1.0X SPRI beads (Rohland & Reich 2012).

Libraries were prepared with 419-2000 ng of starting input DNA using Kapa LTP library prep kit half reactions (Kapa Biosystems, Wilmington MA). Libraries were dual-indexed using the iTru system (Glenn *et al.* 2016), which adds 8bp indices to the adapters of both ends of library fragments for demultiplexing. Next, 500ng of each library were combined into pools of 8 (4,000ng total input DNA) and enriched using a MYcroarray (Ann Arbor, MI) biotinylated RNA probe set designed from 5,237 exons from unique genes from the California tiger salamander genome (McCartney-Melstad *et al.* 2016). Given the relatively close phylogenetic relationships of all members of the tiger salamander complex (Shaffer & McKnight 1996; O'Neill *et al.* 2013), we predicted that most of the probes would also capture the eastern tiger salamander homolog. A total of 30,000 ng of c_0t-1 prepared from *Ambystoma californiense* was used for each capture reaction to block repetitive DNA from hybridizing with probes or captured fragments. Probes were hybridized for 30 hours at 60C, bound to streptavidin-coated beads, and washed four times with wash buffer 2.2 (MYcroarray). Enriched libraries were then amplified on-bead with 14 cycles of PCR, cleaned using 1.0X SPRI beads, and sequenced on three 150bp PE lanes on an Illumina HiSeq 4000.

Reference Assembly

We built a reference assembly for read mapping and SNP calling using the Assembly by Reduced Complexity (ARC) pipeline (Hunter *et al.* 2015). To do this, the reads from the 10 samples that received the greatest number of reads were pooled and mapped to the 5,237 *A. californiense* targets across which capture probes were tiled using bowtie2 v.2.2.6 (Langmead & Salzberg 2012). Pools of reads mapping to each one of these targets were independently assembled using SPAdes v.3.8.2 (Bankevich *et al.* 2012), and the contigs assembled for each target then replaced their respective targets and another round of mapping was performed to these contigs. This process was repeated for 10 iterations to extend assembled targets several hundred bp in both directions from their central probe-tiled regions. Reciprocal best blast hits (RBBHs) were then found to represent each target locus using blast+ 2.2.30 (Camacho *et al.* 2009). The set of RBBHs was then blasted against itself to find similar regions among targets, which may be indicative of chimeric assemblies. Regions within each RBBH that were found to be similar to other RBBHs were trimmed to the ends of the RBBH contigs.

SNP Calling and Genotyping

Reads for all samples were trimmed to 150bp (if the 151st base was reported by the sequencing facility) and adapters were trimmed using skewer 0.1.127 (Jiang *et al.* 2014). These trimmed reads were then mapped to the reference assembly using BWA-mem 0.7.15 (Li 2013). Read group information was added to the aligned reads and PCR duplicates were marked using picard tools v2.0.1 (https://broadinstitute.github.io/picard/).

SNP calling and genotyping was performed according to GATK best practices (DePristo *et al.* 2011; Van der Auwera *et al.* 2013). First, a set of high-quality reference SNPs was generated to assess and recalibrate base quality scores within each sample. HaplotypeCaller from GATK nightly-2016-11-21-g69e703d (McKenna *et al.* 2010) was run separately on each sample in GVCF mode followed by joint genotyping with GenotypeGVCFs. Then, any SNP that met any of the following criteria were removed from the reference set: QD < 2.0, MQ < 40.0, FS > 60.0, MQRankSum < -12.5, ReadPosRankSum < -8.0, QUAL < 100. Similarly, any indel that failed any of the following criteria were also removed from the reference set: QD < 2.0, SOR > 10.0, FS > 60.0, ReadPosRankSum < -8.0, QUAL < 100. Base quality score recalibration was then performed at the lane level (three different platform units among all of the read groups) using GATK.

HaplotypeCaller in GATK was then used with recalibrated reads to generate sample-level GVCF files that were jointly genotyped using GATK's GenotypeGVCFs function. The same hard filters outlined above were then applied to the resulting VCF files, except that all SNPs with QUAL values above 30 (instead of 100) were kept. Genotype calls with phred-scaled quality scores under 20 (1 in 100 chance of being incorrect) were set to "missing" data, and SNPs with greater than 50% missing data were removed. Samples with missing data rates greater than 30% were also removed.

Given the extremely large genomes of ambystomatid salamanders (roughly 30GB) (Licht & Lowcock 1991; Keinath *et al.* 2015), we were concerned about the possibility of including duplicated paralogous loci in our analyses. We attempted to correct for this by filtering out loci that contained excessive heterozygosity, as fixed differences between true paralogs interpreted as homologs will typically appear as variable sites that are always heterozygous. To do this, VCFtools v.0.1.15 was used to calculate p-values for heterozygote excess for every SNP (Wigginton *et al.* 2005; Danecek *et al.* 2011). Target regions that contained at least one SNP with an excess heterozygote p-value below 0.001 were removed from the analysis. A set of SNPs was then generated by randomly choosing a single SNP from each qualifying target region (those targets that did not contain any excessively heterozygous SNPs). This dataset with a single SNP taken from each target region is referred to hereafter as the "linkage-pruned" dataset.

Population Genetic Analysis

The presence of isolation by distance (IBD)—the relationship between geographic and genetic distance—was tested at both the individual and pond (population) levels. Individual genetic similarity was calculated as the percentage of SNPs that were identical-by-state using SNPRelate v1.6.4 (Zheng *et al.* 2012). These values were regressed on geographic distance and the significance of the correlation between genetic distance and geographic distance was tested using a simple Mantel test with 999,999 permutations in the R package vegan 2.4-0 (Mantel 1967; Oksanen *et al.* 2016). At the pond level, Fst/(1-Fst) (Slatkin 1995) was calculated using SNPRelate v1.6.4 and regressed on geographic distance to estimate the slope of isolation by distance. Rousset (1997) recommends regressing Fst/(1-Fst) on the logarithm of geographic distance in the case of two-dimensional habitats or non-transformed geographic distance in the case of one-dimensional habitats. Since the sampling area for this study is very narrow and is over three times longer than it is wide (approximately 15.5 km x 4.5 km), it is unclear whether it is more appropriate to treat the study area as linear or two dimensional, and regressions and Mantel tests are reported for both raw and log-transformed geographic distances. Fst values were also calculated using Arlequin v3.5.2.2 (Excoffier & Lischer 2010) to determine significance p-values using 100,172 permutations of the data. P-values from Arlequin were adjusted for multiple testing using the Benjamini-Yekutieli correction implemented in base R (Benjamini & Yekutieli 2001). For individual-based analyses, logarithms of geographic distances were set to a minimum value of 0.

We were interested in characterizing the level of genetic diversity present in tiger salamanders on Long Island. To estimate genetic diversity we determined per-base pair Watterson's θ, an estimator that characterizes the level of genetic diversity in populations based on the number of segregating sites per base pair sequenced (Watterson 1975). We calculated θ for each pond with samples pooled across years. As a basis of comparison, a population sample of 15 California tiger salamanders (*A. californiense*) from a single pond in Great Valley Grasslands State Park, California (McCartney-Melstad and Shaffer, unpublished data) was genotyped under similar filtering parameters for the same set of loci, and θ was estimated for this group in the same way.

The linkage-pruned dataset was visualized using principal components analysis (PCA) in the R package SNPRelate v1.6.4 (Zheng *et al.* 2012). The first eight principal components were plotted with letters corresponding to the collection sites of samples. The proportion of the variance explained by each principal component was also obtained using SNPRelate v1.6.4.

To estimate the number of distinct population clusters in the data, ADMIXTURE v1.3.0 was run using the linkage-pruned dataset containing all samples from all ponds across all three years of sampling for K=1 to K=30 with ten different random number seeds (Alexander *et al.* 2009). Each replicate was subjected to 100-fold cross validation, and CV errors were used to choose a "reasonable" set of K values. If the standard deviation of CV values for any K value overlapped with the standard deviation of the best-scoring K value, it was included as a reasonable value for K.

Effective population sizes (Ne) for each pond were estimated using the linkage disequilibrium (LD) method in NeEstimator v2.01 with a minor allele frequency cutoff of 0.05 (Hill 1981; Do *et al.* 2014). Estimates were calculated for all cohorts (a given pond in a given year), and, when more than one year of sampling was conducted for a pond, Ne was also calculated for the pooled sample of either two or three cohorts. LD-based estimates of effective population size from single cohorts represent the harmonic mean between the effective number of breeders (Nb) and the true effective population size (Ne) (Waples *et al.* 2016). Alternatively, as the number of pooled cohorts approaches the generation length (the average age of parents for a cohort), LD-based estimators should approach the true Ne (Waples & Do 2010; Waples *et al.* 2014).

Effective population size estimates using the LD method can be downwardly biased for multiple reasons. First, estimates may be biased when many loci are used due to physical linkage among loci, given that the method assumes the loci being used are unlinked (Waples *et al.* 2016). This effect is predictable, however, and can be corrected if the number of chromosomes or total linkage map length is known. Estimates of linkage map length for the closely related axolotl, *Ambystoma mexicanum*, are known, and this number (4200cm) was used to correct estimates of effective population size for dense locus sampling by dividing them by 0.9170819 (which is equal to $-0.910 + 0.219 \times \ln(4200)$) (Voss *et al.* 2011; Waples *et al.* 2016).

LD based estimates of effective population size can also be downwardly biased when analyzing mixed cohorts in iteroparous species such as *A. tigrinum*, although this bias appears to decrease as the number of sampled cohorts approaches the generation length of the species

(Waples & Do 2010; Waples *et al.* 2014). Therefore, single-cohort estimates of Ne were further corrected by dividing dense-locus adjusted estimates by 0.8781801, the product of two equations from Table 3 of Waples et al. (2014) that use the ratio of adult lifespan (estimated at 7 years for the closely related *A. californiense*) to age at maturity (4 years, also in *A. californiense*) (Trenham *et al.* 2000) to compensate for the downward bias introduced by iteroparity: (1.103-0.245 * log(7/4)) * (0.485+0.758 x log(7/4)). For ponds in which multiple years of sampling were conducted, we report both pooled-cohort estimates (corrected for dense locus sampling) and per-cohort estimates (corrected both for dense locus sampling and single-cohort sampling). We used linear regression to visualize the relationship between pond area (as traced from Google Earth images) and effective population size, using multi-year estimates of Ne when available.

Impact of Roads

We were interested in assessing to what degree human habitat modifications have restricted movement of this species, and whether or not human activity has contributed to the observed patterns of population structure. To explore this, we created a matrix that indicated whether or not pairs of ponds were separated by a major road (New York State Route 25, Suffolk CR 46, or Interstate 495, see Figure 6). This matrix was included as a predictor variable for genetic distance in linear regression and was tested for correlations to genetic distance (while controlling for geographic distance) using a partial Mantel test with vegan v2.4-0 in R (Mantel 1967; Smouse *et al.* 1986; R Core Team 2015; Oksanen *et al.* 2016).

Results

Sampling: A total of 283 salamanders were genotyped from 17 ponds spread over an approximately 40 km^2 area (Figure 6, Table 4). More than 1.9 billion 150-bp sequencing reads were generated from three Illumina HiSeq 4000 lanes across these samples (mean=6.8 million reads/sample, min=1.8 million reads, max=10.9 million reads).

Reference assembly: The ten samples that received the most sequencing reads were pooled to generate a *de novo* reference assembly, for a total of 66.9 million merged and paired-end sequencing reads (11.7 billion total bp). Assembly of target regions with the ARC assembler produced a set of 74,109 contigs (47.5 million bp) from which 5,057 reciprocal best blast hits were recovered (6.7 million bp). After blasting these contigs against themselves, trimming self-complementary regions to the ends of contigs, and re-determining reciprocal best blast hits, a 6.6 million bp assembly with 5,050 target regions (96.4% of the originally targeted regions) was recovered for mapping reads and calling SNPs.

SNP Calling and Genotyping: An average of 29.27% of raw reads mapped to the reference assembly using BWA-mem across all 283 samples (sd=2.47%, min=20.33%, max=34.30%). After removing PCR duplicates (read pairs that map to the exact same position on the reference, indicating that they may be PCR amplicons from the same molecule), an average of 17.03% unique reads mapped to the reference (sd=2.47%, min=8.51%, max=24.59%). After joint genotyping, a total of 82,005 raw SNPs were recovered across 4,400 target regions. After applying hard filters to SNP loci, setting the minimum genotype call quality to 20, discarding variants genotyped in less than 50% of all samples, and removing the one sample with a missing data rate greater than 30%, a total of 21,998 biallelic SNPs were retained across 3,631 target regions. Tests for Hardy Weinberg equilibrium revealed 533 targets contained at least one SNP with clear ($p<0.001$) heterozygote excess, which is consistent with (though not definite evidence of) the presence of an unknown paralogous copy of this gene in the genome. After removing these target regions from the analysis, a total of 12,924 biallelic SNPs remained across 3,098 target regions. The final matrix containing 282 individuals had a mean missing data rate of 7.7%

(max=27.8%, min=1.8%, sd=4.5%). The linkage-pruned dataset contained one random biallelic SNP from each final target, for a total of 3,098 variants.

Genetic variation within cohorts: Values of Watterson's θ for ponds ranged from 3.26×10^{-4} to 5.77×10^{-4} (Table 4), and was 3.19×10^{-4} after pooling the 282 samples from all ponds together for a single estimate of θ. The comparative sample of 15 *A. californiense* from a pond in Merced County, CA had a θ value of 7.09×10^{-4}, which was higher than each of the values calculated for ponds in Long Island *A. tigrinum.* This suggests that genetic diversity is lower for *A. tigrinum* in Long Island than it is for *A. californiense* in Great Valley Grasslands State Park, CA, and is in keeping with the low estimates of variation found by Titus *et al.* (2014).

Isolation by Distance (IBD): IBD was apparent at both the individual and pond level (Figures 7 and 8, Table 5). Regressions of individual identity-by-state on both raw and log-transformed geographic distances yielded negative relationships with p-values below 2×10^{-16} (Figure 7). Adjusted R^2 values were higher for log-transformed distances when comparing pairwise individual genetic relationships and geographic distances (0.2861 vs. 0.1764). Similarly, regression coefficients were positive and highly significant when testing for the relationship between pairwise Fst of ponds and raw and log-transformed geographic distances (Figure 8, $p < 2.6 \times 10^{-16}$ and $p < 4.12 \times 10^{-11}$ for raw and log-transformed distances, respectively). Unlike the individual-based measure, the pond-based model with raw geographic distances fit the data better (R^2=0.39) than log-transformed geographic distances (R^2=0.27). Testing the significance of isolation by distance using regression coefficient p-values is inappropriate because many of the pairwise observations are not independent. Therefore, simple Mantel tests were used to test the significance of correlations between pond/individual genetic and raw/log-transformed geographic distances, all of which yielded p-values lower than 0.000011 (Table 5). This indicates that there is a significant relationship between geographic and genetic distance, even at the extremely fine scale studied here.

Pairwise Fst values between ponds ranged from 0.005 to 0.207 (136 comparisons, median=0.064, sd=0.042, Table 6). Using Benjimini-Yekutieli (BY)-corrected p-values, 118 out of 136 of these pairwise comparisons were significantly different from 0. Of the 18 non-significant pairwise comparisons, 16 were from pond L, which contained only a single sample and therefore had extremely low power. Many of the highest Fst values are from pairwise comparisons containing ponds A or Q. These ponds are both outliers separated by greater geographic distances and by major roads from all other ponds (Figure 6).

Principal Component Analysis: The first eight principal components (PCs) are shown as pairwise plots in Figure 9. In all PC graphs, samples are coded by letters representing the ponds from which they were collected (Figure 6). PC1 groups samples from pond A to the exclusion of the other samples, while PC 2 does the same for samples from ponds E, F, and G. PC 3 separates samples from ponds B, C, and D from the other ponds (especially pond N), and PC4 appears to be an axis of variation between ponds J and Q (which is also apparent in PC5). Finally, PCs 6, 7, and 8 correspond to axes that differentiate ponds N, P, and Q, along with some samples from ponds A and J. Overall, clustering of single ponds and small groups of closely adjacent ponds is quite apparent, which indicates the presence of easily detectable population structure with the genomic data that we have collected in this study.

Population Clustering: The value of K in ADMIXTURE with the lowest mean CV error was K=12. Four other K values (9, 10, 11, and 13) had CV error standard deviations that overlapped with K=12 (Figure 10). Admixture proportions for K=9 through K=13 are shown in Figure 11, and are split by both pond and sampling year (Glasbey *et al.* 2007). Results from ADMIXTURE analyses corroborated the qualitative patterns observed in the PCA. First, pond A generally formed one to three clusters to the exclusion of all other ponds (as recapitulated in PCs 1, 6, and 8). Ponds B, C, and D form a single cluster to the exclusion of other ponds (as also seen in PC 3). Similarly, ponds E and G form a unique cluster at K=9 (corresponding to PC 2), but are separated into their own private clusters at K=10 through K=13. Pond F, geographically separated from its closest neighbors (ponds E and G) by NY State Route 25, appears strongly admixed at K=9 through K=12, and receives its own cluster at K=13. Ponds H, I, J, K, L, and M appear to be strongly associated across all K values (though ponds I, L, and M appear highly admixed at these K values), with the exception of one year of sampling in pond J (2014) that produced a group of animals that formed their own cluster. Pond N appears quite distinct across all K values (which can also be seen on PCs 3-8). Pond O appears highly admixed across all K values, but tends to share a considerable admixture component with the cluster formed by pond P (and pond Q for K=9 through K=11). At K=12 and K=13, pond Q forms its own strong cluster to the exclusion of all other ponds, a pattern that is also quite apparent in PC5.

Effective Population Size: Estimates of effective population size ranged from 10.3 for pond N to 135.0 for pond K (Table 4). For ponds with multiple years of sampling, single-cohort estimates were generally close to those for pooled-cohort, with the exception of pond O, which had a pooled-cohort estimate of 68.8 and a 2013-cohort estimate of 17,689. This single-cohort estimate was extremely sensitive to the minor allele frequency cutoff—changing the threshold to 0.10 from 0.05 lowered the estimate to less than 600. The 95% confidence interval was also extremely wide for this cohort estimate, ranging from 953.0 to Infinite/incalculable. The surface area of ponds was strongly correlated with effective population size estimates ($p=0.00122$, $R^2=0.5619$, Figure 12). The number of samples included in the calculation of Ne was not correlated with the resulting Ne estimate (linear regression p=0.513, adj R^2= -0.0438), suggesting that sample size *per se* was not a driver of Ne estimates.

Roads as Barriers to Dispersal: Roads appear to play a strong role in structuring among-pond genetic divergence in Long Island tiger salamanders. Specifically, linear regression supports roads as an explanatory factor in pairwise Fst values between ponds, as adding this term increased the adjusted R^2 of models including only geographic distance from 0.39 to 0.68 (with both terms highly significant). This is apparent from visualizing the distances, as a distinct upwards shift in genetic distance is apparent for pairwise comparisons separated by major roads (Figure 13). Similarly, partial Mantel tests recovered strong and highly significant correlations between genetic distance and being separated (or not) by major roads after controlling for geographic distance (p=0.000608, Mantel R^2=0.48). This suggests that dispersal may be limited across major roads, and that human activity has contributed to isolation of ponds in this relatively highly developed region.

Discussion

Population structure is difficult to detect and quantify accurately in subtly differentiated populations, and populations in close geographic proximity tend to be subtly differentiated (Wright 1943). In conservation genetics, however, we are often interested in understanding limitations in gene flow at the temporal and spatial scales at which humans impact populations. Furthermore, as the number of generations over which humans have affected most populations is usually relatively small, many cases of human-induced structure will be difficult to detect with conventional genetic datasets.

Several amphibian studies have attempted to quantify spatial genetic structure of populations at very fine spatial scales. Jehle *et al.* (2005) found evidence of pond clustering in *Triturus* newts over a 26.5 km^2 landscape using a hierarchical Bayesian clustering algorithm (Corander *et al.*

2003), although ponds did not cluster cleanly in STRUCTURE analyses (Pritchard *et al.* 2000). Hitchings and Beebee (1997) used allozyme data in common frogs in the UK and found evidence for significant structuring over a few kilometers in urbanized environments, but not in rural environments, suggesting that human development was acting to isolate ponds from one another in this system. Similarly, Lampert et al. (2003) recovered significant isolation by distance over roughly 8km between ponds in Túngara frogs (*Physalaemus pustulosus*), although 51 of 64 pairwise Fst values on the same side of the 100m-wide Chagres River were non-significant, and no population clustering methods were attempted. Conversely, Newman and Squire (2001) recovered significant differentiation and isolation by distance in wood frogs (*Rana sylvatica*) ponds separated by roughly 20km but could not genetically differentiate ponds at closer distances. Lampert *et al.* (2003) attributed the differences in discriminating power between these two studies to the low levels of diversity in microsatellite loci for wood frogs. Zamudio and Wieczorek (2007) found evidence for two genetic clusters of *Ambystoma maculatum* from 29 ponds spread over 1272km^2 in upstate New York, but little support for substructuring among ponds within each cluster. A number of other studies have found strong support for population structure among breeding ponds of amphibians in small landscapes using microsatellite loci (Wang *et al.* 2009, 2011, Wang 2009b, 2012; Savage *et al.* 2010). Conversely, several amphibian studies using microsatellites have failed to find significant genetic differentiation among ponds for pond-breeding amphibians (Coster *et al.* 2015; Furman *et al.* 2016), while others have found evidence of isolation by distance and limited clustering (Sotiropoulos *et al.* 2013; Peterman *et al.* 2015).

These studies illustrate that, in amphibians, genetic differentiation is sometimes detectable at very fine spatial scales, and sometimes it is not. This may hinge largely on the variability of the markers studied, which itself is shaped by deeper-time demographic processes such as bottlenecks and range expansions (Watterson 1984; Slatkin 1993). While microsatellite loci have been extremely valuable for conservation genetics, a panel of 20 microsatellites (which is towards the high end employed by most studies) has been shown in one instance to be approximately as effective for estimating genetic relationships as 50 SNP loci (Santure *et al.* 2010). While it is laborious to increase the number of microsatellite loci above the 20 or so that are typically used in conservation genetics, it is very straightforward to scale the number of SNPs assayed into the thousands or tens of thousands, which greatly increases our ability to distinguish barriers to gene flow that are subtle or have only been operating for a small number of generations (Patterson *et al.* 2006; Anderson *et al.* 2010). As genomic-scale datasets become comparable with microsatellites in terms of cost and feasibility, the added resolution from thousands of loci will give a particular boost to population genetic studies in systems with low genetic diversity, and will open entire new classes of analyses to both low- and high-diversity systems.

While a lack of statistical power is one reason why population structure may not be detected in pond-breeding amphibians, another possibility is that, even in low-vagility species, ponds in some systems are truly unstructured, and that failing to recover population structure reflects a biological reality of panmixia across these ponds. Differentiating between low resolving power and true panmixia is critical for conservation and management decision makers. Multiple studies of the same systems with both conventional and genomic datasets can help clarify whether the null hypothesis of population differentiation and strong isolation by distance is a general rule for pond-breeding amphibians, or whether such rules may be habitat or lineage-specific.

The current study is among the first to use thousands of nuclear loci across hundreds of individuals in a large-genome amphibian, and represents an opportunity to compare results between the two genetic approaches in the same system. While little genetic clustering was apparent in the microsatellite loci analyzed by Titus et al. (2014), our dataset of thousands of nuclear SNPs reveals clear population genetic structuring among breeding ponds of *Ambystoma tigrinum* on Long Island. The major genetic patterns in our data are readily apparent in both ADMIXTURE and PCA results. Genetic structuring of ponds generally shows consistent results across years (Figure 11), with two exceptions. First, samples from 2013 in Pond A were classified consistently as a unique population that is admixed with the Pond A lineages sampled in 2014 and 2015. Second, some of the samples from 2014 in Pond J appear to belong to a unique lineage that was not sampled in any other ponds or years. Aside from these two results, consistency between sampling years in the different ponds suggests that the observed patterns of genetic structure are likely driven by geography and not year-to-year variation.

Species with low genetic diversity require collecting data from a greater number of genetic loci to detect population structure (Patterson *et al.* 2006). One cause of low genetic diversity is a range expansion. Church *et al.* (2003) analyzed *Ambystoma tigrinum* mitochondrial DNA and determined that New York was likely recolonized by salamanders from Pleistocene refugia in North Carolina. This was corroborated by Titus et al. (2014), who found low genetic diversity in microsatellite loci in New Jersey and Long Island tiger salamanders. To try to understand whether this low genetic diversity led to the apparent differences between microsatellite and target capture datasets, we compared estimates of genetic diversity from Long Island tiger salamanders to other amphibian systems. Crawford (2003) used a single gene (*c-myc*) to estimate θ in populations of *Eleutherodactylus* frogs in Costa Rica and Panama and obtained values ranging from 0.00080 to 0.01148 (excluding one population that was fixed for a single haplotype across eight diploid individuals). Weisrock *et al.* (2006) estimated θ at eight nuclear loci from 217 *Ambystoma ordinarium* (a member of the *Ambystoma tigrinum* complex) larvae from across the geographic range of the species (spanning roughly 200km) and obtained an average θ of 0.00208 across loci (min=0.0006, max=0.0034). Similarly, Nadachowska and Babik (2009) sequenced eight nuclear loci for 20 different populations of smooth newt subspecies in Turkey (*Lissotriton vulgaris kosswigi* and *Lissotriton vulgaris vulgaris*). They calculated θ for each population and, after averaging across loci, recovered population estimates ranging from 0.0019 to 0.0081. Finally, we calculated θ as 0.000709 in a collection of 15 *A. californiense* from Merced County, CA. This calculation was performed for a collection of individuals across the same set of nuclear loci presented here, so it is the most direct comparison available. All of these values of θ are greater than the largest value obtained in Long Island tiger salamander ponds (0.000577, mean=0.000427), which indicates that these populations likely do have lower genetic diversity than is normally seen in amphibians.

Breeding ponds that we examined generally exhibited small effective population sizes (< 100), consistent with results found for many other amphibian species (Schmeller & Merilä 2007; Phillipsen *et al.* 2011; McCartney-Melstad & Shaffer 2015). Our estimates (mean=36.9) are larger than, but of the same magnitude as microsatellite-based estimates performed by Titus *et al.* (2014) using the sibship method (Wang 2009a), which had a mean value of 20.9. We did, however, recover several ponds with effective population sizes higher than 44, which was the maximum value recovered by Titus *et al.* (2014). These included pond H (Ne=91.0), pond K (Ne=135.0), pond M (Ne=82.9), and pond O (Ne=68.8). This may indicate that the area around these ponds, which was not directly sampled by Titus et al. (2014), may harbor greater effective population sizes than elsewhere on Long Island.

A clear relationship between pond size and effective population size was recovered ($p=0.00122$, $R^2=0.5619$, Figure 12). This relationship has been previously observed in *A. californiense* (Wang *et al.* 2011). Interestingly, the pond for which surface area did the worst job predicting Ne, Pond H, had a much higher effective population size estimate than expected by the model (that is, it had the largest residual from the regression line). Pond H is geographically closest pond to Pond K, which has the largest effective population size estimate of any pond. The landscape between Pond H and Pond K is largely forested with no major roads or other anthropogenic barriers to gene flow, the Fst value between ponds H and K is the lowest of any pairwise comparison between ponds (Fst=0.005, Table 6), and these ponds are consistently recovered in the same cluster in ADMIXTURE analyses. Taken together, this suggests that migration has been common between Pond H and Pond K, and that the effective population size of Pond H is augmented by its close relationship with the very large Pond K.

Our approach afforded us the resolution to evaluate the contributions of human disturbance on the movement of salamanders in the form of roads limiting dispersal between ponds. Based on the y-intercepts of linear regressions, the presence of a major road between ponds raised Fst values by approximately 0.04. Pond A was quite distinct from all the other ponds, as was Pond Q (Table 6). These ponds are generally separated from other ponds by greater geographic distance, but they are also separated from all other ponds by major roads. Similarly, ponds E and G tend to separate from all other ponds (PC2 in Figure 9)—these are the only ponds besides pond A that are north of New York State Route 25, a high-traffic road that constitutes a substantial barrier to salamander movement. The combination of geographic distance and roads did an excellent job of explaining the observed genetic distances between ponds (linear regression, adj. R^2=0.6814). These results suggest that both geographic distance and the presence of roads have affected salamander dispersal for many generations, which has important implications for conservation strategies.

Conclusion

The results of this study show that *Ambystoma tigrinum* ponds on Long Island generally have relatively small effective population sizes that are correlated with the surface area of ponds, that migration is limited among most ponds in the area, and that major roads further limit dispersal. The interrelationships between these factors are important for conservation management. Small effective population sizes imply that ponds are more likely to suffer random demographic extinction, and highly structured populations indicate that locally extirpated ponds (such as those that do not fill with water for many years in a row) may not be easily recolonized by individuals from nearby ponds. Roads and other human activities add to these natural dynamics, and emphasize the critical importance of conserving blocks of contiguous habitat with a complex of ponds that can act as semi-isolated metapopulations. Within the Long Island landscape studied here, there appear to be several clusters of interconnected ponds that periodically share migrants (ponds B, C, and D; ponds H, I, J, K, L, and M; and ponds O and P). For such clusters migrants from interconnected ponds may be expected to "rescue" nearby ponds that go locally extinct, and maintaining these dynamics is probably critical to the long-term persistence of tiger salamanders locally. However, the presence of major roads appears to disrupt this pattern, as seen by the tendency of nearby ponds separated by major roads to fall out in different genetic clusters (such as Pond A vs. ponds B, C, and D and Pond F vs. ponds E and G).

A genomic approach was critical for this experiment to detect the observed population structure at such a fine spatial scale in a post-glacially recolonized area. The distinction between inferences made from relatively few microsatellite loci from the data generated in this study have important consequences for our understanding of ecological dynamics in the system. Titus *et al.* (2014) recovered little genetic structure among endangered populations of Long Island tiger salamanders and inferred relatively high migration rates between ponds. Conversely, our genomic approach revealed the restrictions in movement between many groups of ponds, despite low overall levels of genetic differentiation.

This study suggests that monitoring of individual ponds is necessary, especially during and following droughts. Our genetic results suggest that ponds not separated by major roads may have increased resilience to local extirpation via demographic rescue from neighboring ponds, so efforts should be made to prevent activities that separate such clusters of ponds. In the event of an observed local extirpation of a pond, the genetic results herein provide information regarding the best source of animals to use for translocations to preserve the current genetic landscape, which is a result of a combination of current and historical patterns of dispersal among ponds.

Acknowledgments

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Figures

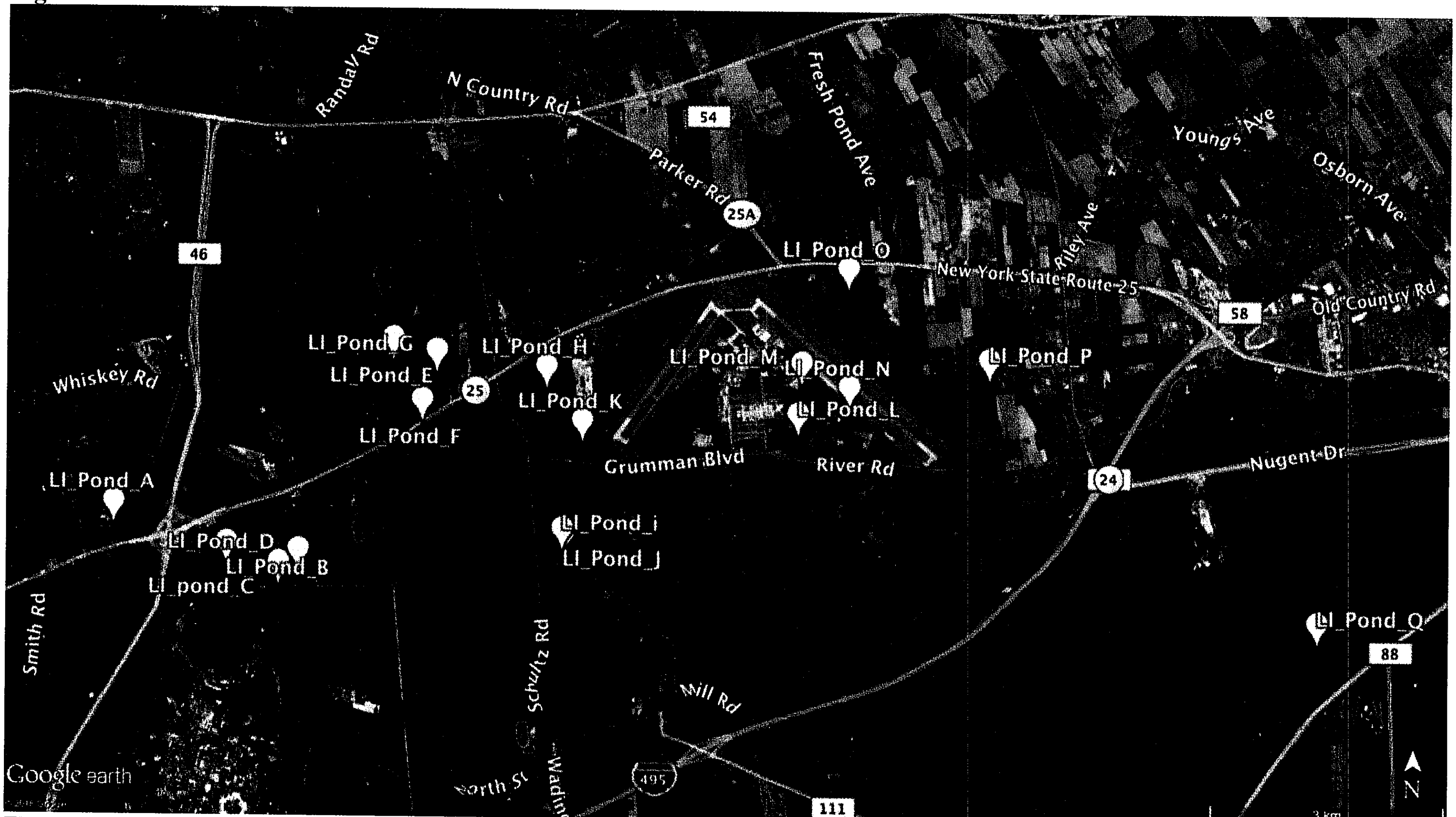

Figure 6: Map of sampling localities.

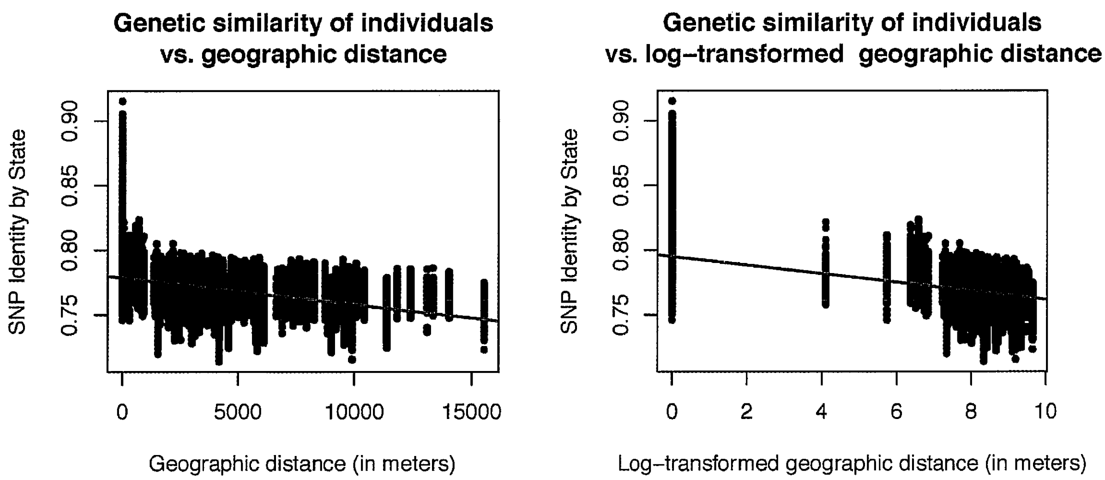

Figure 7: Relationship between genetic similarity and geographic distance between individuals. The plot on the left uses raw Euclidean distance between individuals, while the plot on the left uses log-transformed Euclidean distances.

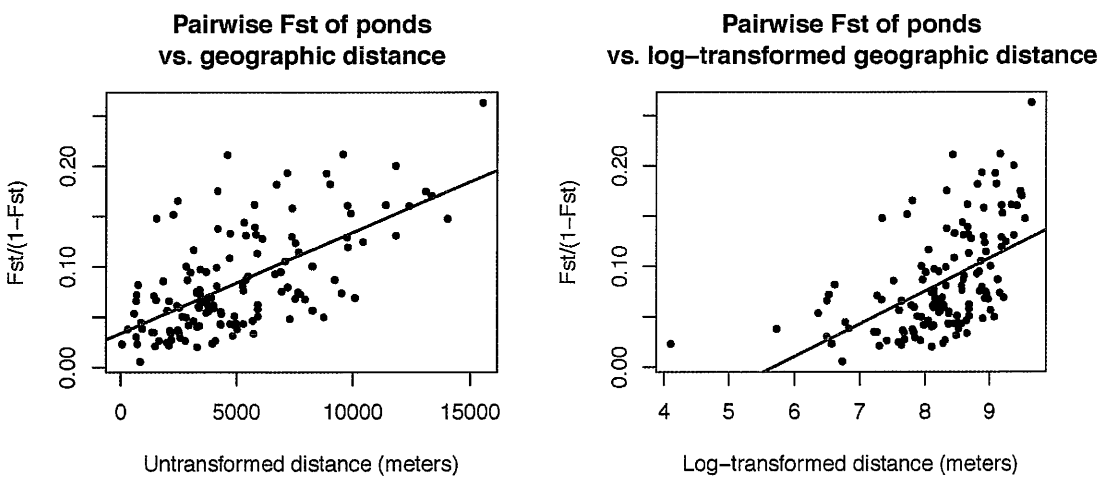

Figure 8: Relationship between genetic distance and geographic distance between ponds. The plot on the left uses raw Euclidean distance between ponds, while the plot on the left uses log-transformed Euclidean distances.

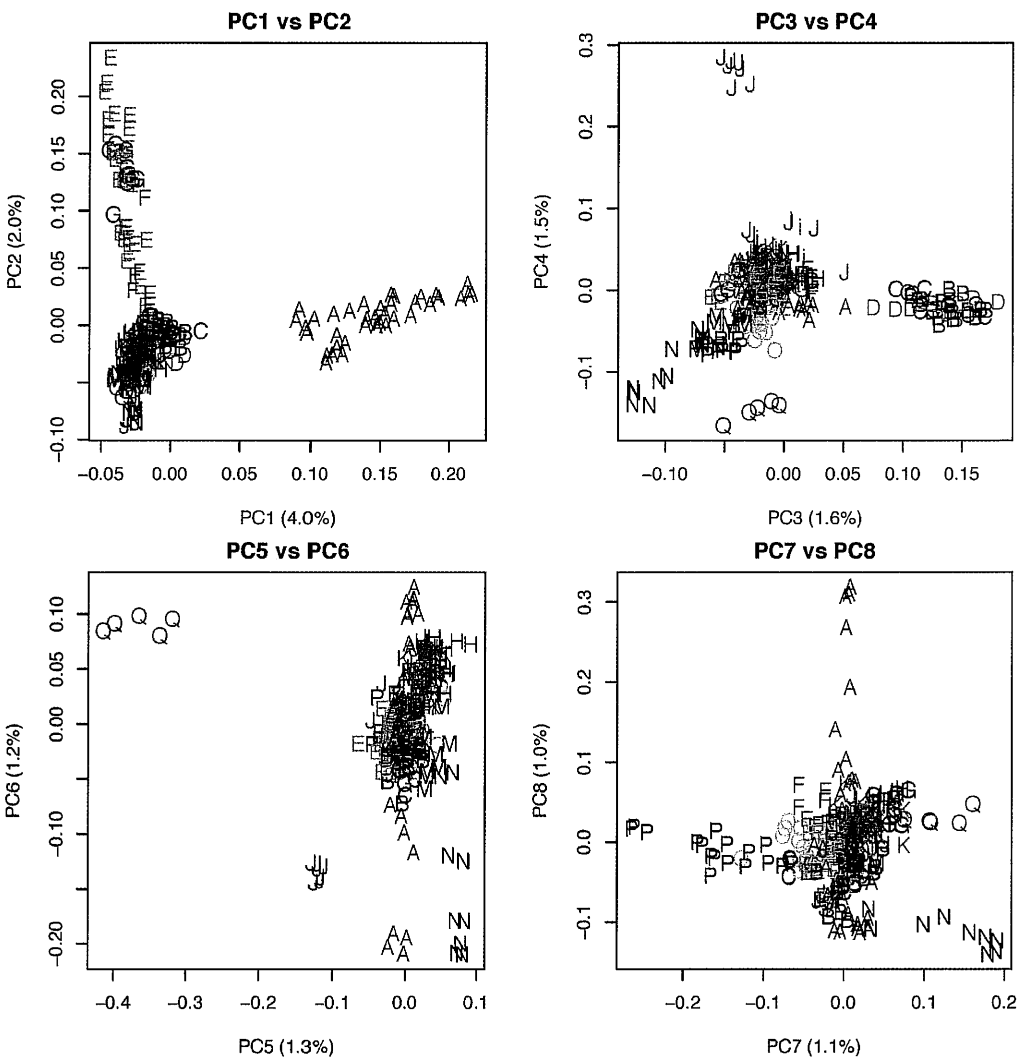

Figure 9: First eight principal components of the data. Letters on the graph correspond to samples from the same pond. Colors are used only to aid in distinguishing between letters.

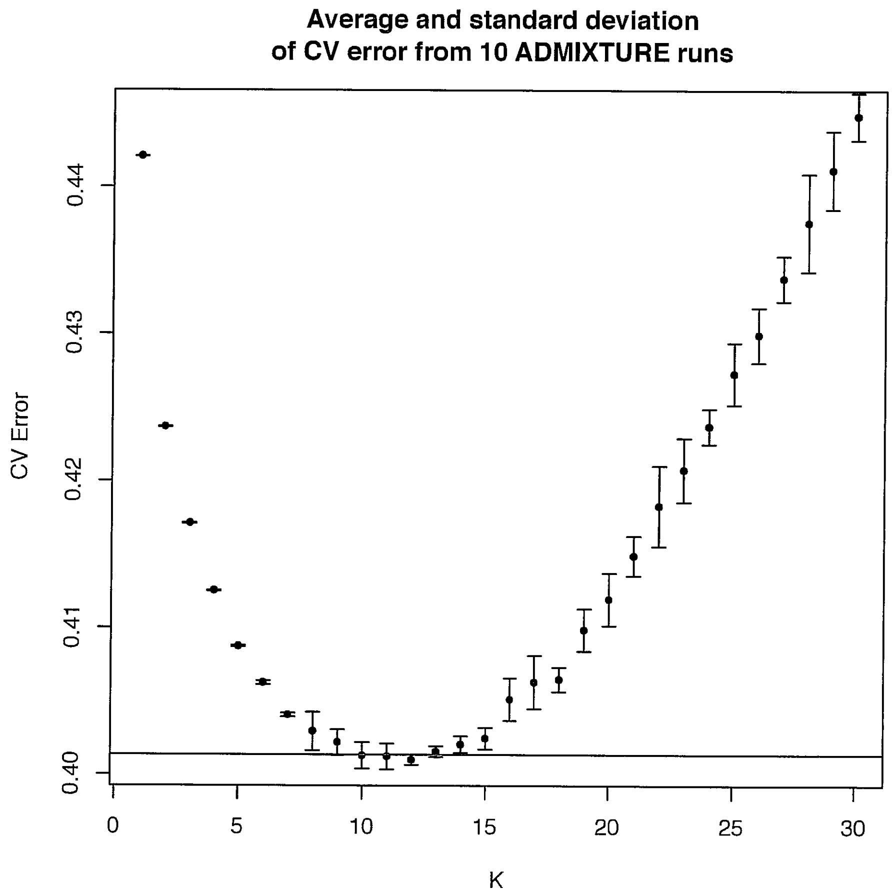

Figure 10: Cross-validation error mean and standard deviations from 10 ADMIXTURE runs using different seeds. The red line is drawn at the mean+SD of the best-performing K value (K=12). The standard deviations for K=9 through K=13 overlap this line.

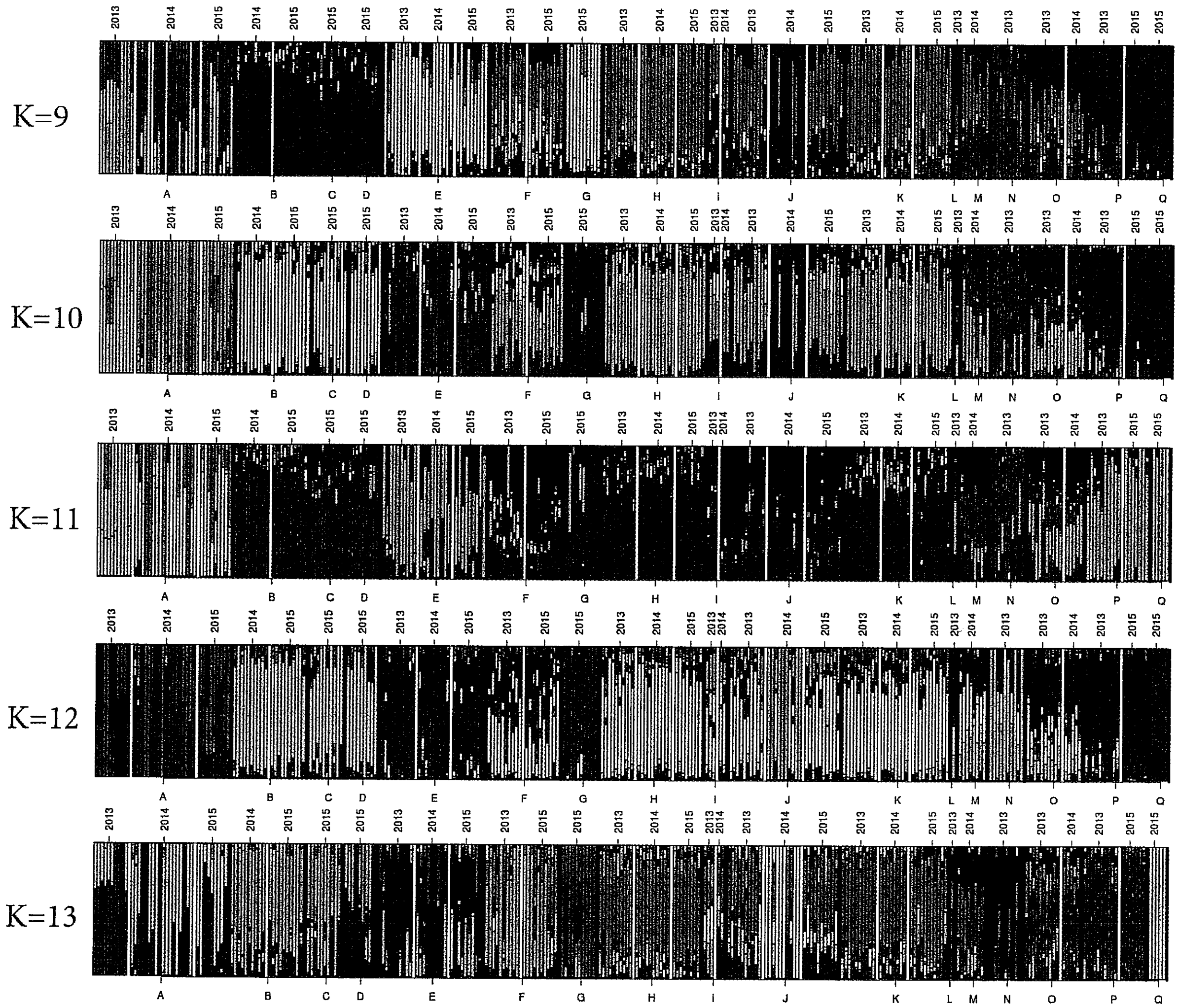

Figure 11: Admixture results from all 282 samples. Letters correspond to ponds from the sample map (Figures 6 and 9). White vertical lines separate sampling years within ponds, and black vertical lines separate ponds from one another.

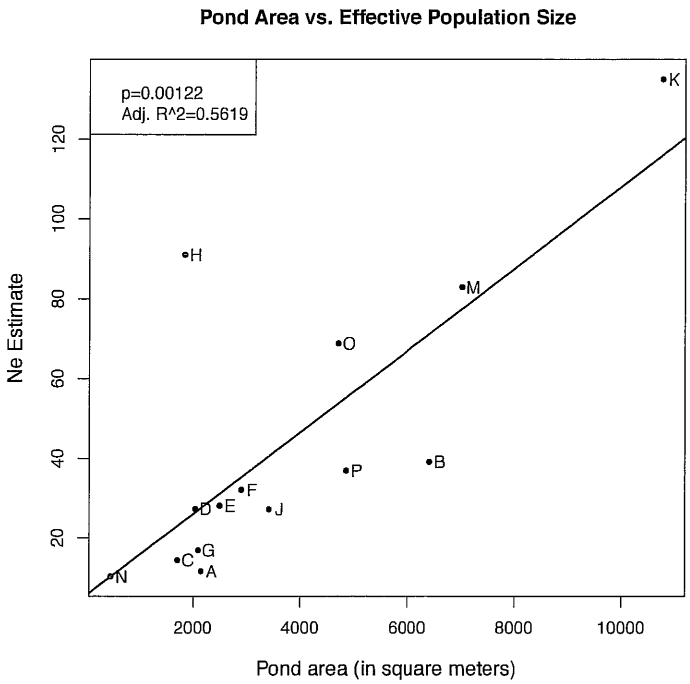

Figure 12: Relationship between pond area and effective population size estimate. Ne estimates represent multiple-cohort calculations if multiple cohorts were samples, otherwise adjusted single-year estimates were used. Ponds i, L, and Q were omitted because they did not contain enough samples to generate an estimate of Ne.

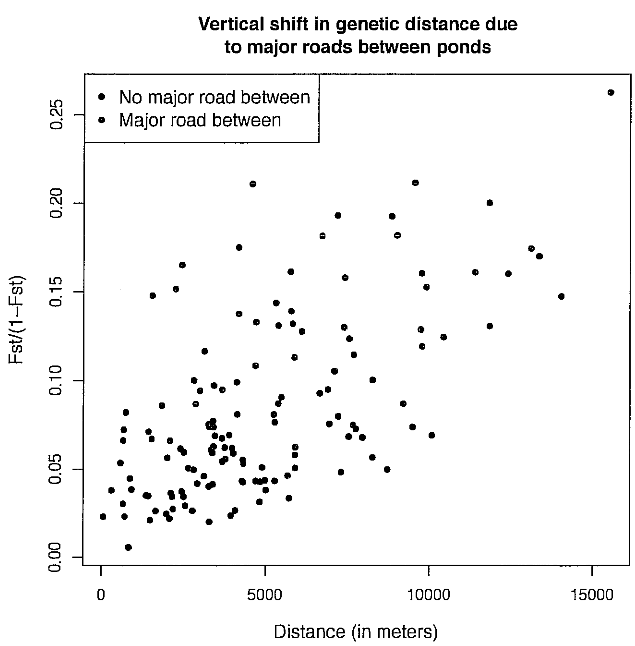

Figure 13: Visualizing the impacts of major roads on genetic differentiation between ponds. For the same geographic distance, ponds separated by major roads (indicated by red dots) tend to have higher levels of genetic differentiation.

Tables

Table 4: Pond localities, areas, Watterson's θ estimates, sampling, and effective population size estimates. Pond areas were estimated from Google Earth satellite images taken in March 2007. Single-year estimates were corrected for iteroparity-induced downward bias as explained in Methods, and both single-year and pooled-year estimates were corrected for dense locus sampling on chromosomes. Infinite values indicate that sample sizes were likely too small to estimate Ne. N=number of samples included in analyses. Ne=Effective population size estimates using LD method.

Pond	Latitude	Longitude	Pond Area (m^2)	Watterson's θ	N (2013/2014/2015)	Ne (2013/2014/2015)
A	40.896379	-72.892071	2147	$3.26x10^{-4}$	37 (10/18/9)	11.6 (6.7/7.1/20.1)
B	40.891766	-72.874854	6413	$4.05x10^{-4}$	20 (0/10/10)	39.1 (NA/37.7/47.2)
C	40.889497	-72.866932	1706	$4.45x10^{-4}$	10 (0/0/10)	14.4 (NA/NA/14.4)
D	40.891043	-72.863908	2039	$4.38x10^{-4}$	9 (0/0/9)	27.3 (NA/NA/27.3)
E	40.915705	-72.849554	2493	$3.75x10^{-4}$	28 (10/9/9)	28.1 (40.4/14.3/19.7)
F	40.908597	-72.845109	2898	$4.16x10^{-4}$	20 (10/0/10)	32.1 (30.8/NA/31.3)
G	40.914317	-72.842938	2094	$4.21x10^{-4}$	10 (0/0/10)	16.9 (NA/NA/16.9)
H	40.912580	-72.826168	1840	$4.06x10^{-4}$	28 (10/10/8)	91.0 (55.5/187.2/515.2)
I	40.893704	-72.823658	944	$4.98x10^{-4}$	5 (3/2/0)	Inf (Inf/Inf/NA)
J	40.893182	-72.823465	3418	$3.94x10^{-4}$	30 (10/10/10)	27.2 (136.2/4.0/91.3)
K	40.906296	-72.820671	10773	$4.07x10^{-4}$	29 (10/8/11)	135.0 (602.1/Inf/27.4)
L	40.907237	-72.787736	8587	$5.77x10^{-4}$	1 (1/0/0)	Inf (Inf/NA/NA)
M	40.913165	-72.787206	7020	$4.62x10^{-4}$	8 (0/8/0)	82.9 (NA/82.9/NA)
N	40.910430	-72.779946	464	$4.22x10^{-4}$	10 (10/0/0)	10.3 (10.3/NA/NA)
O	40.924112	-72.780170	4710	$4.36x10^{-4}$	15 (10/5/0)	68.8 (17689.4/Inf/NA)
P	40.913681	-72.758595	4854	$4.15x10^{-4}$	17 (10/0/7)	36.9 (Inf/NA/11.1)
Q	40.883585	-72.708374	1302	$4.08x10^{-4}$	5 (0/0/5)	Inf (NA/NA/Inf)

Test	**R_M**	**R_M^2**	**p-value**
Individual with log(geographic distance)	0.5349	0.2861	$1x10^{-6}$
Individual with raw geographic distance	0.4200	0.1764	$1x10^{-6}$
Ponds with log(geographic distance)	0.5276	0.2784	$1x10^{-6}$
Ponds with raw geographic distance	0.6305	0.3975	$1.1x10^{-5}$

Table 5: Mantel test results: P-values calculated using 999,999 permutations. R_M is the Mantel R statistic, and R_M^2 is the square of the Mantel R statistic.

	A	B	C	D	E	F	G	H	i	J	K	L	M	N	O	P	Q
A																	
B	0.127																
C	0.129	0.020															
D	0.129	0.030	**0.022**														
E	0.147	0.066	0.069	0.072													
F	0.119	0.043	0.044	0.048	0.040												
G	0.173	0.085	0.086	0.091	0.050	0.060											
H	0.115	0.038	0.041	0.042	0.052	0.022	0.066										
i	0.137	0.050	0.061	0.059	0.068	0.034	0.088	0.035									
J	0.120	0.048	0.050	0.045	0.056	0.031	0.080	0.026	0.022								
K	0.111	0.037	0.040	0.039	0.047	0.018	0.062	0.005	0.033	0.020							
L	**0.159**	**0.072**	**0.064**	**0.099**	**0.071**	**0.039**	**0.111**	**0.018**	**0.043**	**0.041**	**0.024**						
M	0.151	0.066	0.070	0.076	0.073	0.047	0.095	0.037	0.056	0.051	0.038	**0.028**					
N	0.173	0.090	0.100	0.102	0.101	0.082	0.123	0.064	0.088	0.074	0.064	**0.069**	0.065				
O	0.128	0.045	0.049	0.055	0.054	0.031	0.076	0.021	0.038	0.033	0.018	**0.030**	0.030	0.059			
P	0.136	0.063	0.065	0.071	0.066	0.043	0.092	0.040	0.052	0.045	0.037	**0.033**	0.056	0.077	0.031		
Q	0.207	0.131	0.142	0.144	0.139	0.118	0.164	0.111	**0.135**	0.115	0.106	**0.153**	0.135	0.151	0.110	0.116	

Table 6: Pairwise Fst values between ponds. Cells are colored by the magnitude of difference between ponds, with red being relatively low differentiation and green being relatively high differentiation. Bolded cells/values are not significantly different from 0 (p > Benjamini-Yekutieli-corrected 0.05).

References

Alexander DH, Novembre J, Lange K (2009) Fast model-based estimation of ancestry in unrelated individuals. *Genome Research*, 1655–1664.

Anderson CD, Epperson BK, Fortin M-J *et al.* (2010) Considering spatial and temporal scale in landscape-genetic studies of gene flow. *Molecular Ecology*, **19**, 3565–3575.

Bankevich A, Nurk S, Antipov D *et al.* (2012) SPAdes: a new genome assembly algorithm and its applications to single-cell sequencing. *Journal of Computational Biology*, **19**, 455–477.

Benjamini Y, Yekutieli D (2001) The control of the false discovery rate in multiple testing under dependency. *The Annals of Statistics*, **29**, 1165–1188.

Bishop SC (1941) *The salamanders of New York.* University of the State of New York.

Blaustein AR, Wake DB, Sousa WP (1994) Amphibian Declines: Judging Stability, Persistence, and Susceptibility of Populations to Local and Global Extinctions. *Conservation Biology*, **8**, 60–71.

Camacho C, Coulouris G, Avagyan V *et al.* (2009) BLAST+: architecture and applications. *BMC Bioinformatics*, **10**, 421.

Church SA, Kraus JM, Mitchell JC, Church DR, Taylor DR (2003) Evidence for Multiple Pleistocene Refugia in the Postglacial Expansion of the Eastern Tiger Salamander, Ambystoma Tigrinum Tigrinum. *Evolution*, **57**, 372–383.

Corander J, Waldmann P, Sillanpää MJ (2003) Bayesian Analysis of Genetic Differentiation Between Populations. *Genetics*, **163**, 367–374.

Coster SS, Babbitt KJ, Cooper A, Kovach AI (2015) Limited influence of local and landscape factors on finescale gene flow in two pond-breeding amphibians. *Molecular Ecology*, **24**, 742–758.

Crawford AJ (2003) Huge populations and old species of Costa Rican and Panamanian dirt frogs inferred from mitochondrial and nuclear gene sequences. *Molecular Ecology*, **12**, 2525–2540.

Danecek P, Auton A, Abecasis G *et al.* (2011) The variant call format and VCFtools. *Bioinformatics*, **27**, 2156–2158.

DePristo MA, Banks E, Poplin RE *et al.* (2011) A framework for variation discovery and genotyping using next-generation DNA sequencing data. *Nature genetics*, **43**, 491–498.

Do C, Waples RS, Peel D *et al.* (2014) NeEstimator v2: re-implementation of software for the estimation of contemporary effective population size (Ne) from genetic data. *Molecular Ecology Resources*, **14**, 209–214.

Excoffier L, Lischer HE (2010) Arlequin suite ver 3.5: a new series of programs to perform population genetics analyses under Linux and Windows. *Molecular ecology resources*, **10**, 564–567.

Furman BLS, Scheffers BR, Taylor M, Davis C, Paszkowski CA (2016) Limited genetic structure in a wood frog (Lithobates sylvaticus) population in an urban landscape inhabiting natural and constructed wetlands. *Conservation Genetics*, **17**, 19–30.

Glasbey C, van der Heijden G, Toh VFK, Gray A (2007) Colour displays for categorical images. *Color Research & Application*, **32**, 304–309.

Glenn TC, Nilsen R, Kieran TJ *et al.* (2016) Adapterama I: Universal stubs and primers for thousands of dual-indexed Illumina libraries (iTru & iNext). *bioRxiv*, 049114.

Hill WG (1981) Estimation of effective population size from data on linkage disequilibrium. *Genetics Research*, **38**, 209–216.

Hitchings SP, Beebee TJ (1997) Genetic substructuring as a result of barriers to gene flow in urban Rana temporaria (common frog) populations: implications for biodiversity conservation. *Heredity*, **79**, 117–127.

Hunter SS, Lyon RT, Sarver BAJ *et al.* (2015) Assembly by Reduced Complexity (ARC): a hybrid approach for targeted assembly of homologous sequences. *bioRxiv*.

Jehle R, Burke T, Arntzen JW (2005) Delineating fine-scale genetic units in amphibians: Probing the primacy of ponds. *Conservation Genetics*, **6**, 227–234.

Jiang H, Lei R, Ding S-W, Zhu S (2014) Skewer: a fast and accurate adapter trimmer for next-generation sequencing paired-end reads. *BMC Bioinformatics*, **15**, 182.

Keinath MC, Timoshevskiy VA, Timoshevskaya NY *et al.* (2015) Initial characterization of the large genome of the salamander Ambystoma mexicanum using shotgun and laser capture chromosome sequencing. *Scientific Reports*, **5**, 16413.

Keinath MC, Voss SR, Tsonis PA, Smith JJ (2016) A linkage map for the Newt Notophthalmus viridescens: Insights in vertebrate genome and chromosome evolution. *Developmental Biology*.

Lampert KP, Rand AS, Mueller UG, Ryan MJ (2003) Fine-scale genetic pattern and evidence for sex-biased dispersal in the túngara frog, Physalaemus pustulosus. *Molecular Ecology*, **12**, 3325–3334.

Langmead B, Salzberg SL (2012) Fast gapped-read alignment with Bowtie 2. *Nature Methods*, **9**, 357–359.

Li H (2013) Aligning sequence reads, clone sequences and assembly contigs with BWA-MEM. *arXiv:1303.3997 [q-bio]*.

Licht LE, Lowcock LA (1991) Genome size and metabolic rate in salamanders. *Comparative Biochemistry and Physiology Part B: Comparative Biochemistry*, **100**, 83–92.

Madison DM, Farrand L (1998) Habitat Use during Breeding and Emigration in Radio-Implanted Tiger Salamanders, Ambystoma tigrinum. *Copeia*, **1998**, 402–410.

Mantel N (1967) The detection of disease clustering and a generalized regression approach. *Cancer Research*, **27**, 209–220.

McCartney-Melstad E, Mount GG, Shaffer HB (2016) Exon capture optimization in amphibians with large genomes. *Molecular Ecology Resources*, **16**, 1084–1094.

McCartney-Melstad E, Shaffer HB (2015) Amphibian molecular ecology and how it has informed conservation. *Molecular Ecology*, **24**, 5084–5109.

McKenna A, Hanna M, Banks E *et al.* (2010) The Genome Analysis Toolkit: a MapReduce framework for analyzing next-generation DNA sequencing data. *Genome research*, **20**, 1297–1303.

Nadachowska K, Babik W (2009) Divergence in the Face of Gene Flow: The Case of Two Newts (Amphibia: Salamandridae). *Molecular Biology and Evolution*, **26**, 829–841.

New York State Department of Environmental Conservation (2015) Eastern tiger salamander fact sheet. Available http://www.dec.ny.gov/animals/7143.html. (Accessed September, 2016).

Newman CE, Austin CC (2016) Sequence capture and next-generation sequencing of ultraconserved elements in a large-genome salamander. *Molecular Ecology*, In press.

Newman RA, Squire T (2001) Microsatellite variation and fine-scale population structure in the wood frog (Rana sylvatica). *Molecular Ecology*, **10**, 1087–1100.

Oksanen J, Blanchet FG, Friendly M *et al.* (2016) The vegan package. *https://CRAN.R-project.org/package=vegan.*

O'Neill EM, Schwartz R, Bullock CT *et al.* (2013) Parallel tagged amplicon sequencing reveals major lineages and phylogenetic structure in the North American tiger salamander (Ambystoma tigrinum) species complex. *Molecular Ecology*, **22**, 111–129.

Patterson N, Price AL, Reich D (2006) Population structure and eigenanalysis. *PLoS Genet*, **2**, e190.

Peterman WE, Anderson TL, Ousterhout BH *et al.* (2015) Differential dispersal shapes population structure and patterns of genetic differentiation in two sympatric pond breeding salamanders. *Conservation Genetics*, **16**, 59–69.

Phillipsen IC, Funk WC, Hoffman EA, Monsen KJ, Blouin MS (2011) Comparative analyses of effective population size within and among species: Ranid frogs as a case study. *Evolution*, **65**, 2927–2945.

Polich RL, Searcy CA, Shaffer HB (2013) Effects of tail-clipping on survivorship and growth of larval salamanders. *The Journal of Wildlife Management*, 77, 1420–1425.

Portik DM, Smith LL, Bi K (2016) An evaluation of transcriptome-based exon capture for frog phylogenomics across multiple scales of divergence (Class: Amphibia, Order: Anura). *Molecular Ecology Resources*, **16**, 1069–1083.

Pritchard JK, Stephens M, Donnelly P (2000) Inference of population structure using multilocus genotype data. *Genetics*, **155**, 945–959.

R Core Team (2015) R: A language and environment for statistical computing. https://www.R-project.org/.

Raj A, Stephens M, Pritchard JK (2014) fastSTRUCTURE: Variational Inference of Population Structure in Large SNP Data Sets. *Genetics*, **197**, 573–589.

Reyes-Valdés MH (2013) Informativeness of Microsatellite Markers. In: *Microsatellites* Methods in Molecular Biology Vol 1006. (ed Kantartzi SK), pp. 259–270. Humana Press.

Rohland N, Reich D (2012) Cost-effective, high-throughput DNA sequencing libraries for multiplexed target capture. *Genome Research*, **22**, 939–946.

Rousset F (1997) Genetic Differentiation and Estimation of Gene Flow from F-Statistics Under Isolation by Distance. *Genetics*, **145**, 1219–1228.

Sambrook J, Russell DW (2001) *Molecular cloning: a laboratory manual (3-volume set)*. Cold Spring Harbor Laboratory Press, Cold Spring Harbor, New York.

Santure AW, Stapley J, Ball AD *et al.* (2010) On the use of large marker panels to estimate inbreeding and relatedness: empirical and simulation studies of a pedigreed zebra finch population typed at 771 SNPs. *Molecular Ecology*, **19**, 1439–1451.

Savage WK, Fremier AK, Bradley Shaffer H (2010) Landscape genetics of alpine Sierra Nevada salamanders reveal extreme population subdivision in space and time. *Molecular Ecology*, **19**, 3301–3314.

Schmeller DS, Merilä J (2007) Demographic and genetic estimates of effective population and breeding size in the amphibian Rana temporaria. *Conservation Biology*, **21**, 142–151.

Shaffer HB, Gidiş M, McCartney-Melstad E *et al.* (2015) Conservation Genetics and Genomics of Amphibians and Reptiles. *Annual Review of Animal Biosciences*, **3**.

Shaffer HB, McKnight ML (1996) The Polytypic Species Revisited: Genetic Differentiation and Molecular Phylogenetics of the Tiger Salamander Ambystoma tigrinum (Amphibia: Caudata) Complex. *Evolution*, **50**, 417–433.

Slatkin M (1993) Isolation by Distance in Equilibrium and Non-Equilibrium Populations. *Evolution*, **47**, 264–279.

Slatkin M (1995) A Measure of Population Subdivision Based on Microsatellite Allele Frequencies. *Genetics*, **139**, 457–462.

Smouse PE, Long JC, Sokal RR (1986) Multiple Regression and Correlation Extensions of the Mantel Test of Matrix Correspondence. *Systematic Zoology*, **35**, 627–632.

Sotiropoulos K, Eleftherakos K, Tsaparis D *et al.* (2013) Fine scale spatial genetic structure of two syntopic newts across a network of ponds: implications for conservation. *Conservation Genetics*, **14**, 385–400.

Stewart MM, Rossi J (1981) The Albany Pine Bush: a northern outpost for southern species of amphibians and reptiles in New York. *American Midland Naturalist*, 282–292.

Sun C, Shepard DB, Chong RA *et al.* (2012) LTR Retrotransposons Contribute to Genomic Gigantism in Plethodontid Salamanders. *Genome Biology and Evolution*, **4**, 168–183.

Titus VR, Bell RC, Becker CG, Zamudio KR (2014) Connectivity and gene flow among Eastern Tiger Salamander (Ambystoma tigrinum) populations in highly modified anthropogenic landscapes. *Conservation Genetics*, **15**, 1447–1462.

Trenham PC, Bradley Shaffer H, Koenig WD, Stromberg MR, Ross ST (2000) Life history and demographic variation in the California tiger salamander (Ambystoma californiense). *Copeia*, **2000**, 365–377.

Van der Auwera GA, Carneiro MO, Hartl C *et al.* (2013) From FastQ data to high confidence variant calls: the Genome Analysis Toolkit best practices pipeline. *Current Protocols in Bioinformatics / Editoral Board, Andreas D. Baxevanis ... [et Al.]*, **43**, 11.10.1-33.

Voss SR, Kump DK, Putta S *et al.* (2011) Origin of amphibian and avian chromosomes by fission, fusion, and retention of ancestral chromosomes. *Genome Research*, **21**, 1306–1312.

Wang J (2009a) A new method for estimating effective population sizes from a single sample of multilocus genotypes. *Molecular Ecology*, **18**, 2148–2164.

Wang IJ (2009b) Fine-scale population structure in a desert amphibian: landscape genetics of the black toad (Bufo exsul). *Molecular Ecology*, **18**, 3847–3856.

Wang IJ (2012) Environmental and topographic variables shape genetic structure and effective population sizes in the endangered Yosemite toad. *Diversity and Distributions*, **18**, 1033–1041.

Wang IJ, Johnson JR, Johnson BB, Shaffer HB (2011) Effective population size is strongly correlated with breeding pond size in the endangered California tiger salamander, Ambystoma californiense. *Conservation Genetics*, **12**, 911–920.

Wang IJ, Savage WK, Bradley Shaffer H (2009) Landscape genetics and least-cost path analysis reveal unexpected dispersal routes in the California tiger salamander (Ambystoma californiense). *Molecular Ecology*, **18**, 1365–1374.

Waples RS, Antao T, Luikart G (2014) Effects of Overlapping Generations on Linkage Disequilibrium Estimates of Effective Population Size. *Genetics*, **197**, 769–780.

Waples RS, Do C (2010) Linkage disequilibrium estimates of contemporary Ne using highly variable genetic markers: a largely untapped resource for applied conservation and evolution. *Evolutionary Applications*, **3**, 244–262.

Waples RK, Larson WA, Waples RS (2016) Estimating contemporary effective population size in non-model species using linkage disequilibrium across thousands of loci. *Heredity*, **117**, 233–240.

Watterson GA (1975) On the number of segregating sites in genetical models without recombination. *Theoretical Population Biology*, **7**, 256–276.

Watterson GA (1984) Allele frequencies after a bottleneck. *Theoretical Population Biology*, **26**, 387–407.

Weisrock DW, Shaffer HB, Storz BL, Storz SR, Voss SR (2006) Multiple nuclear gene sequences identify phylogenetic species boundaries in the rapidly radiating clade of Mexican ambystomatid salamanders. *Molecular Ecology*, **15**, 2489–2503.

Wigginton JE, Cutler DJ, Abecasis GR (2005) A Note on Exact Tests of Hardy-Weinberg Equilibrium. *The American Journal of Human Genetics*, **76**, 887–893.

Wright S (1943) Isolation by Distance. *Genetics*, **28**, 114–138.

Zamudio KR, Wieczorek AM (2007) Fine-scale spatial genetic structure and dispersal among spotted salamander (Ambystoma maculatum) breeding populations. *Molecular Ecology*, **16**, 257–274.

Zheng X, Levine D, Shen J *et al.* (2012) A high-performance computing toolset for relatedness and principal component analysis of SNP data. *Bioinformatics (Oxford, England)*, **28**, 3326–3328.

Short-eared Owl Facts


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Identification

Short-eared owls are medium-sized owls with small ear tufts on the top of the head. They have round, beige facial discs, and white/buff (male) or tawny/rust (female) underparts streaked with brown. In flight, the long wings show a buff patch above and a black wrist mark and tip below. The short-eared owl appears big-headed and neck-less in its buoyant, moth-like flight. Its voice sounds like the nasal bark of a dog, "wak, wak."

Life History

Short-eared owls are most often seen in the late afternoon and at dawn or dusk. They primarily eat small mammals, but occasionally take small birds; their young sometimes eat insects. When hunting, these owls dive from perches or fly low over the ground and pounce on their prey from above.

These birds prefer the open country of grasslands and marshes, inhabiting areas where small mammals are plentiful. Their population changes, breeding behaviors and nest success change from year to year based on their food supply. Breeding occurs in March through June. Their courtship entails elaborate flight displays that include wing-clapping, exaggerate wing beats and scuffles.


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The shallow, unlined nest of the short-eared owl is built on the ground, sheltered by tall grass, reeds or bushes. The short, oval eggs are laid in 2-day intervals; the female incubates the eggs, beginning with the first egg, for 24 to 28 days. After hatching, the female tends the nest while the male brings food. The young owls leave the nest 12 to 17 days after hatching, but do not fly until 10 days later.

In winter, short-eared owls gather in open habitats, such as open grasslands, marshes, landfills, and fallow fields, that support large numbers of small mammals, especially meadow voles. The owls will stay in their wintering grounds unless deep snow and ice reduce the availability of prey, then they may leave to find a more suitable place to finish out the winter. In areas where food remains plentiful into the spring and summer, short-eared owls may take advantage of these favorable conditions and stay to breed.

Short-eared Owl Facts

Range

Short-eared owls are found on every continent except Australia and Antarctica. New York is the southern edge of this owl's breeding range. Northern populations are believed to be highly migratory,, and there is a noticeable increase in the number of short-eared owls in New York in the fall and spring, but they are more common in New York in winter.

Status

Short-eared owls are Endangered in New York State. Their conservation depends on protecting relatively large, opens sites that support small rodents. Doing so will likely have the added benefit of protecting other imperiled grassland birds with similar habitat requirements.

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Recent efforts have been made to more closely monitor wintering raptors in New York State, including at Montezuma. Research has lead to a better understanding of the importance of wintering raptor concentration areas to short-eared owls, and their response to changes in habitat and environmental conditions.

Information gathered through research and monitoring will help guide conservation efforts for this and other grassland species.

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Interesting Facts

- While caring for its young, a short-eared owl will perform an "injured bird" act to lead away intruders.
- During courtship, male short-eared owls will fly high over the nest, calling, flapping, soaring and occasionally swooping while clapping its wings below its body.
- Short-eared owls generally roost on low perches or on the ground.
- While short-eared owls dine on small mammals and an occasional small bird, they prefer meadow voles.

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Commissioner

Guidance for Land Cover Set Asides for Conservation of the Eastern Tiger Salamander And Suggested Methods to Avoid, Minimize, and Mitigate Impacts

In the discharge of its authority and responsibility to protect and conserve endangered species under ECL Article 11-0535 and associated regulations 6 NYCRR § 182.6, and as a general matter, DEC urges developers to minimize adverse impacts to tiger salamanders by conforming with both of the following when designing projects that would occur on lands within 1,000 feet of known tiger salamander breeding ponds (measurements should be taken from average water level based on water marks, rack lines and vegetation):

a) Preserving 100% of the existing upland forest habitat within 535 feet of the breeding pond.

b) Preserving a minimum of 50% of the adjacent upland area within 1,000 feet of breeding ponds in contiguous blocks of suitable habitat, while allowing for the preservation of wooded corridors which provide connections to adjacent tiger salamander upland habitats. The exact configuration of this habitat is subject to the particular site history and habitat features of a project site.

In general, the habitat closest to the wetland is given a higher priority, with a secondary priority being the preservation of intact corridors of habitat that will allow animals to move off of the subject parcel to other suitable habitat if they choose to do so. Where possible, development is encouraged within existing disturbed areas. The preferred habitat of the salamanders is mature oak-pine woodlands. In general, the preserved area should contain as much oak pine woodland as possible, with development occurring on existing footprints of previous buildings, parking areas, roadways or tilled fields. Therefore, the optimal layout for any particular site can vary depending on site specific features such as historic land use, habitat coverage, and adjacent land cover. In addition, preserved areas should remain undisturbed with no grading, excavation, clearing or similar physical activity allowed except as noted below. DEC may request that additional measures be undertaken to protect preserved upland areas including installation of fencing, signage, supplemental plantings of native woody species, and closure of existing pathways that currently provide access to such preserved areas.

Additional requirements:

Roadways: For all newly constructed roadways within 1,000 feet of known tiger ponds, at least one culvert suitable for the passage of migrating tiger salamanders must be placed under the roadway for every 100 feet of roadway within 1,000 feet of known breeding ponds. All curbing installed within 1000 feet must have a minimum height of 8" above grade on the side facing out from the roadbed to prevent tiger salamanders from inadvertently crossing the road and being killed. This curbing should also be sloped (1:3) on the side facing in from the roadbed to allow salamanders the ability to exit the road back to their natural habitat. Another approved curb design is also called Cape Cod Curbing (see Figure 1).   Curbing must also be placed around leaching pools, catch basins and similar storm water drainage structures to prevent inadvertent entry of tiger salamanders into these structures.

Pools: All pools within 1,000 feet of tiger salamander breeding ponds must be surrounded by a steeply-sided curb of no less than 8" above grade and which also extends well below the surface.

Other Created Bodies of Surface Water (e.g. recharge or decorative ponds, etc.): All other created (man-made) bodies of surface water within 1,000 feet of tiger salamander breeding ponds must be surrounded by a steeply-sided curb of no less than 4" above grade and which also extends well below the surface.

Window wells: All window wells must be constructed so that either the lip of the well is a minimum of 4" above grade or else a steeply-sided curb of no less than 4" above grade is constructed around the area enclosing the window well.

Lighting: New lighting shall be directed away from Tiger Salamander ponds and should be of a spectrum that does not interfere with the biological activity of this species.

Public Water Supply Wells and Other Groundwater Wells: New groundwater wells for potable water supply, irrigation, firefighting and other purposes should be placed at a distance sufficient from any tiger salamander breeding pond so as to ensure that operation of the well does not result in significant adverse drawdown of surface water levels in the pond.

Use of the preserved area for drainage: The breeding pond must not be utilized as a catch basin for drainage. However, water may be directed into the preserved area as long as the area receiving water does not drain into the breeding pond, the area of upland habitat will not be significantly impacted or altered (e.g. covered with rip-rap), the area of upland habitat receiving storm water is sufficiently small in size so as not to represent a significant percentage of upland tiger salamander habitat and significant quantities of sediment are not introduced into the area.

Mosquito Control and Pesticides: No application of larvicides containing Methoprene shall be made to tiger salamander breeding ponds. No predatory fish such as Gambusia or other finfish may be introduced into Tiger Salamander breeding ponds. Applications of other pesticides or implementation of other mosquito control techniques may require DEC approval.

Management of Preserved Upland Habitat Areas: Appropriate and adequate management plans will be developed and implemented for the management of upland tiger salamander habitat areas preserved as a result of this policy. Said management plans will identify the owner of the preserved area and procedures undertaken to protect and preserve the area. Such measures may include but shall not be limited to frequent patrols of the preserved area; closing of access points to motorized vehicles including cars, trucks, ATVs, motorbikes as well as horses and mountain bikes; restrictive covenants; maintenance and preservation of existing vegetation; planting of supplemental vegetation in denuded areas; fencing; etc.

[10-26-10]

Figure 1: Example of Cape Cod Curbing