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Managing Raptor-Aircraft Collisions on a Grand Scale: Summary of a Wildlife Services Raptor Relocation Program

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ABSTRACT: Bird-aircraft collisions (bird strikes) pose a serious safety risk to aircraft. Raptors (i.e., hawks and owls) are one of the most frequently struck guild of birds within North America. Integrated wildlife damage management programs combine a variety of non-lethal and lethal management tools to reduce the presence and duration of raptors at airports. Live-capture and translocation away from an airport is a commonly used method to reduce the risk of raptor-aircraft collisions. In 2007, USDA APHIS Wildlife Services (WS) developed an airport program-specific plastic leg band (i.e., black with yellow alpha-numerics) for use in operational raptor management activities by the agency at airports. As part of this nation-wide effort, WS airport biologists live-captured, marked with auxiliary markers (i.e., project-specific leg band), and conducted over 3,900 raptor translocations from airports and military bases located in 16 states during January 2008-May, 2015. This represents a large portion of the raptors that were managed using this non-lethal method by WS during these years. Not unexpectedly, raptor translocation efforts and the raptor species managed varied among geographic regions/states and at specific airport locations due to a variety of logistical factors. Fifteen different raptor species were marked and translocated during this effort. Red-tailed hawks, American kestrels, and great horned owls accounted for 58%, 14%, and 6% of marked/translocated birds, respectively. Although research is needed to better understand and increase the efficacy of such management efforts, this non-lethal method of reducing the presence of individual raptors at airports will be an important component of future wildlife damage mitigation programs.

KEY WORDS: airports, birds, bird strikes, human safety, management, raptors, translocation, vertebrate pest control

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INTRODUCTION

Wildlife-aircraft collisions (wildlife strikes) pose a serious safety risk to aircraft. Wildlife strikes cost civil aviation at least $708 million annually in the United States (Dolbeer et al. 2015). Over 156,100 wildlife strikes with civil aircraft were reported to the U.S. Federal Aviation Administration during 1990–2014 (Dolbeer et al. 2015). White-tailed deer (*Odocoileus virginianus*), gulls (*Larus* spp.), waterfowl such as Canada geese (*Branta canadensis*), raptors (hawks and owls), blackbirds (Icterinae), and European starlings (*Sturnus vulgaris*) are the species presently of most concern at airports (Dolbeer et al. 2000, DeVault et al. 2011, Dolbeer et al. 2015). Sound management techniques that reduce the presence and abundance of wildlife hazardous to aviation in and around airports are therefore critical for safe airport operations (DeVault et al. 2013).

Large-scale killing of wildlife to solve human-wildlife conflicts is generally undesirable or impractical (Dolbeer 1986, Dolbeer et al. 1997). Non-lethal frightening (hazing) techniques to keep hazardous birds and deer away from airports are available (Marsh et al. 1991, Cleary and Dolbeer 2005), but can be cost-prohibitive or only temporarily effective (Dolbeer et al. 1995, Washburn et al. 2006).

Raptors (i.e., hawks and owls) are one of the most frequently-struck bird guilds within North America. Integrated wildlife damage management programs combine a variety of non-lethal and lethal management tools to reduce the presence of raptors on airports. Given high public interest, logistical and financial constraints, and other factors, managing raptors at airports presents unique challenges. Non-lethal tools are favored by the public, so airports with a raptor translocation program often receive strong public support.

Habitat management within airport environments is the most important long-term component of an integrated wildlife damage management approach to reduce the use of airfields by birds and mammals that pose hazards to aviation (Cleary and Dolbeer 2005, Washburn and Seamans 2013). Frequently mowing of the airfield, managing for a homogenous grass type, and maintaining sparse vegetation are indirect methods to reduce foraging opportunities for raptors within the airport environment as these factors impact prey abundance. Pesticide use, sometimes permitted and might reduce grasshopper (an attractant for American kestrels, *Falco sparverious*) or small mammal (an attractant for most species of raptors) abundance (Witmer and Fantinato 2003, Washburn et al. 2011), might reduce the presence of foraging raptors.

Live-capture and translocation of problematic individuals is a common practice used in the management of human-wildlife conflicts situations (Fisher and Lindenmayer 2000, Sullivan et al. 2015). This method is often used to reduce the hazards posed by raptors using airport environments (Schafer et al. 2002, Cleary and Dolbeer 2005, Guerrant et al. 2013). There is no published information available regarding the efficacy of raptor live-capture and translocation for reducing raptor-aircraft collisions. Consequently, scientific evaluations are needed as they are essential for the development of effective raptor management methods within airport environments. In this paper we summarize a large-scale (i.e., nationwide) raptor live-capture, marking, and translocation program conducted by USDA APHIS Wildlife Services (WS) during 2008-2015.

WS State Programs Involved

Airport wildlife biologists and specialists from WS operational programs in 16 states conducted all field activities for this raptor-aircraft strike reduction effort, making it national in scope. Due in part to this effort, WS received the 2014 Presidential Migratory Bird Federal Stewardship Award in recognition of the management of raptor-human conflicts to promote safety and migratory bird conservation. Of the 3,934 raptor translocations that took place as part of this program, 29%, 20%, 18%, and 13% occurred in the states of Missouri, Utah, Colorado, and California, respectively (Table 1). The diversity and number of raptors translocated within a state is a direct reflection of the composition and abundance of raptor communities using the airfields, and thus posing a risk to safe aircraft operations, within a given state.

Table 1. Total number of individual raptors and total number of raptor translocations away from airports, by state, conducted by USDA Wildlife Services airport wildlife management programs during 2008-2015.

State	Number of Birds	Number of Translocations
Missouri	1,097	1,129
Utah	748	777
Colorado	664	699
California	470	501
Washington	138	163
Maryland	162	162
Maine	105	109
Nebraska	92	94
Alabama	65	76
Wisconsin	58	66
Oregon	41	43
Texas	29	37
Alaska	17	29
New Jersey	25	26
Florida	13	13
Nebraska	10	10

Live-capture and Marking of Raptors

WS operations personnel used a variety of standard methods to live-capture individual raptors of 15 different species that were presenting a hazard to aircraft on an airport or military airfield during 2008-2015 (Bub 1991, Bloom et al. 2007). Almost two-thirds of all raptor live-captures on airports occurred using Swedish goshawk traps and approximately one-third of the raptors were caught using pole traps (e.g., modified padded foothold traps) and bal-chatri traps (Figure 1). In some cases, specific traps were used more frequently for individual raptor species. For example, bow-nets were used to capture about two-thirds of the snowy owls (*Bubo scandiacus*) and over half of the American kestrels were caught in decoy traps used primarily to capture blackbirds and European starlings. Overall, the success of this large-scale effort required the use of numerous standard raptor live-trapping tools (e.g., Swedish goshawk traps, pole traps) in addition to less commonly used methods (e.g., carpet noose). Given the complexities involved, to be successful a raptor translocation program requires flexibility and the use of several live-capture tools (i.e., traps), as well as the fact that conducting the actual field activities must have considerable knowledge and skill. All raptor trapping activities were conducted under Federal Depredation Permits issued by the U.S. Fish and Wildlife Service, as well as the appropriate state-level depredation permits.

All raptors that were live-captured and translocated as part of this WS operational program were marked with a project-specific color-coded leg band under the lead author's Master Bird Bander Permit (issued by the U.S. Geological Survey Bird Banding Laboratory). These leg bands were black in color with yellow alpha-numeric codes. Each band had the two-letter abbreviation for the state program (e.g., CA = California; MO = Missouri, etc.) and a 3-digit numeric code. These unique markers allowed for the identification of individual raptors when the birds were not "in hand." Federal bird bands were not placed on the birds.

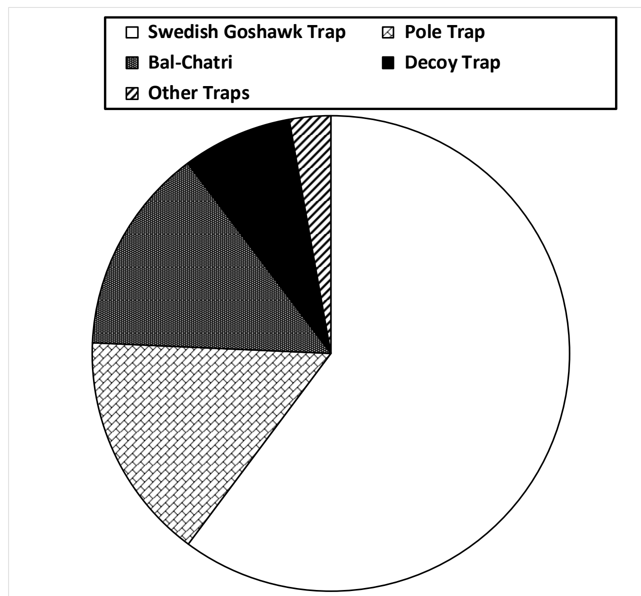

Figure 1. Distribution of trap types used to live-capture 15 species of raptor on civil airports or military airfields by USDA APHIS Wildlife Services as part of an airport wildlife hazard management program (2008-2015).

Translocation of Raptors

During 2008-2015, a total of 3,748 individual raptors were involved in 3,934 translocation events conducted by WS airport wildlife hazard management programs. Notably, some individual raptors were translocated more than once. Red-tailed hawks (*Buteo jamaicensis*), American kestrels, and great horned owls (*Bubo virginianus*) accounted for 58%, 14%, and 6% of these translocated actions, respectively (Table 2). The distance that raptors were transported from the airport of capture varied among species, state programs, airports, and other factors. Across the 15 raptor species, the average

Table 2. Total number of individual raptors and total number of raptor translocations away from airports of 15 species of raptor as part of a USDA Wildlife Services airport management program during 2008-2015.

Common Name	Scientific Name	Number of Birds	Number of Translocations
Red-tailed hawk	*Buteo jamaicensis*	2,131	2,282
American kestrel	*Falco sparverious*	547	560
Great horned owl	*Bubo virginianus*	237	238
Swainson's hawk	*Buteo swainsoni*	205	215
Barn owl	*Tyto alba*	205	211
Cooper's hawk	*Accipiter cooperii*	185	187
Rough-legged hawk	*Buteo lagopus*	76	78
Ferruginous hawk	*Buteo regalis*	46	48
Snowy owl	*Bubo scandiacus*	35	35
Prairie falcon	*Falco mexicanus*	22	23
Northern harrier	*Circus cyaneus*	15	17
Red-shouldered hawk	*Buteo lineatus*	13	13
Merlin	*Falco columbarius*	11	12
Sharp-shinned hawk	*Accipiter striatus*	10	10
Burrowing owl	*Athene cunicularia*	5	5
All Species Combined		**3,743**	**3,934**

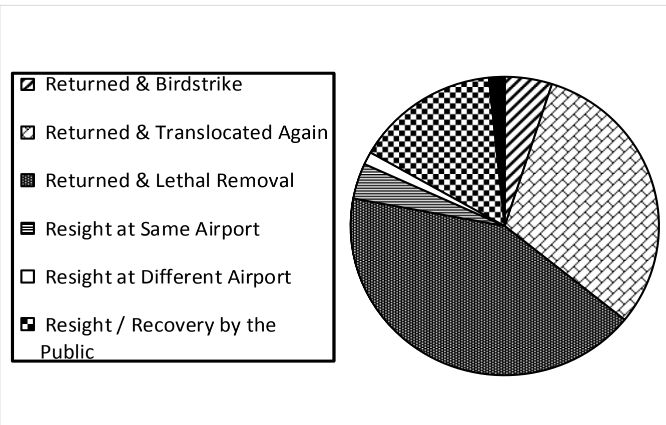

Figure 2. Distribution of the known fate of 363 raptors that were translocated from civil airports or military airfields by USDA APHIS Wildlife Services as part of an airport wildlife hazard management program (2008-2015).

translocation distance was 68 miles away from the airport or airfield where a raptor was live-captured. On average, merlins (*F. columbarius*) were taken the shortest distance (37.4 miles) and Swainson's hawks (*Buteo swainsoni*) were transported the farthest (89.1 miles). The minimal distance raptors were transported was nine miles, whereas the maximum distance was 425 miles.

Fate of Translocated Birds

When a translocated and marked raptor was resighted/recovered by a member of the public or WS personnel, the pertinent information was provided to the Master Bander and entered into a database. Overall, the known fate (e.g., bird strike, second translocation, resight) of 363 individual raptors was reported. Sixty-one raptors (16.8% of the birds with a known fate) were observed or found by the public, whereas 297 (81.9%) returned to same airport or military airfield from which they were translocated (Figure 2). Interestingly, five raptors eventually were reported (or managed) at a different airport. Of the raptors that returned to the same airport, 5% were involved in bird strikes, 90% were managed [i.e., lethally removed (52%) or translocated again (38%)], and the rest (5%) were resighted but were not recaptured or managed. Policies regarding management of raptors that return to an airport following a translocation event varied among the airports and military airfields. Many airports employed a strategy that focused lethal removal toward raptors that returned following a translocation, reserving trap/ translocation efforts for "new" birds. Some airports expended considerable effort and resources to retrap the returning birds and translocated them for a second or third time.

For all raptor species where more than 50 individual birds were live-captured and translocated during this program, we examined each species (n = 7) individually. We were unable to determine a true return rate as some birds could have returned to the airport for a short period of time and were not discovered before they left. The recovery/resight rate (i.e., proportion of translocated raptors that returned to the same airport or military airfield) varied among the seven raptor species: red-tailed hawks had the highest recovery/resight rate, whereas Cooper's hawks (*Accipiter cooperii*) had the lowest (Table 3). Overall, the recovery/resight rate of all raptors was below 10% during this operational program.

For the aforementioned seven species of raptors, we also estimated the number of days to return (i.e., the number of days from translocation until the bird was resighted or recaptured at the airport) for each species. The average number of days to return varied among the seven species, with barn owls (*Tyto alba*) returning the quickest and Cooper's hawks taking the longest amount of time to return (Table 3). Except for great horned owls, at least one individual raptor from each of the species returned within one week of translocation. Overall, the recovery/resight rate for individual raptors varied considerably (Table 3). Several biological (e.g., age/sex of individuals) and logistical (e.g., season, distance translocated from airport) factors could have strong influence on recovery/resight rate and days to return for raptors, and we strongly suggest that researchers and wildlife managers evaluate these factors to increase our understanding of raptor management.

Table 3. Percent of birds that returned to the airport they were translocated from and the average, minimum, and maximum days until birds returned, by species, for all raptor species that at least 50 individuals were translocated as part of a USDA Wildlife Services airport management program during 2008-2015.

Species	Recovery/ Resight Rate	Days to Return		
		Avg.	Min.	Max.
Red-tailed hawk	8.9%	206.9	1	2,048
American kestrel	6.1%	166.5	3	1,425
Great horned owl	3.4%	145.1	24	544
Swainson's hawk	6.0%	271.2	8	720
Barn owl	7.1%	50.9	2	193
Cooper's hawk	2.1%	275.3	7	971
Rough-legged hawk	5.1%	126.3	7	343

Of the 215 recovery/resight returns where age of the bird was determined, almost all (n = 191) were red-tailed hawks. During 2008-2010, most age determinations were classified as either hatching-year (HY) or after-hatching-year (AHY). Starting in summer of 2010, subpermittees were requested to record age by more detailed age classes [i.e., HY, second-year (SY), after-second-year (ASY), third-year (TY), and after-third-year (ATY)], only using AHY when absolutely necessary. The lowest resight/recovery rate was for HY hawks, SY resight/recovery birds were intermediate, and the more mature birds (e.g., ASY and ATY) exhibited the highest resight/recovery rates (Table 4). Raptors exhibit high site fidelity during breeding and migration periods (Preston and Beane 2009), a factor that could result in older birds being more likely to return to an airport than younger hawks. In addition, the natural high mortality of HY hawks might be responsible for their low resight/recovery rates. Further research into the influence of bird age on return rates could help airport wildlife biologists increase the efficacy of their raptor management programs.

We believe these return rates are likely conservative, as detection and identification of marked raptors using colored leg bands can be challenging, and not all raptors that returned to airport environments were observed or recaptured. Similarly, the days to return estimates for some raptors might be somewhat longer due to the same issues. We suggest that future research efforts should be conducted to evaluate the use of other auxiliary markers (e.g., patagial wing tags), which could allow for higher detectability rates of raptors that return to airport environments.

Table 4. Percent of red-tailed hawks, among various age classes, that returned to the airport they were translocated from as part of a USDA Wildlife Services airport management program during 2008-2015.

Age Class	Recovery/Resight Rate
Hatching-year	4.7%
Second-year	7.8%
After-hatching-year	16.5%
After-second-year & Third-year & After-third-year	15.3%

Wildlife strike reporting involving civil aircraft in the United States is voluntary and many reports are incomplete (i.e., species struck and location information is lacking; Dolbeer et al. 2015). Consequently, we were unable to effectively quantify changes in raptor strike rates at airports as a result of this nationwide effort. Nonetheless, the removal of a hazardous raptor from an airport environment increases the safety of aircraft operations at that airport (for some period of time, at a minimum). This benefit increases exponentially at civil airports and military airfield with an active integrated wildlife mitigation program (e.g., those with a dedicated airport wildlife biologist or team), as additional raptors that immigrate into the airport environment or translocated raptors return can be effectively managed (e.g., trapped and translocated) to increase aviation safety.

SUMMARY

Live-capture and translocation of raptors is an important component of integrated wildlife damage mitigation programs at airports. As part of a large multi-year program, WS personnel successfully live-captured and translocated a variety of raptor species that were posing a risk to safe aircraft operations at civil airports and military airfields. Overall, the return rates of translocated raptors appears to be relatively low (<10%) and could be influenced by a number of factors, including species, season, topography, age of the bird, and others. Most airports that use a raptor trap and translocation program believe it is a useful tool for mitigating raptor hazards to aircraft in a manner that provides considerable value from a public relations and perception standpoint. Banding or marking birds is an essential component of any raptor translocation program. Future research efforts will be important for increasing our understanding and the efficacy of raptor-aircraft collision reduction programs.

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