

Rodent population management at Kansas City International Airport

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Abstract: Birds pose serious hazards at United States airports because of the potential for collisions with aircraft. Raptors, in particular, are hazardous to aircraft safety due to their size, hunting behavior, and hovering and soaring habits. Reduction of rodent populations at an airport may decrease raptor populations in the area and, therefore, reduce risk that raptors pose to aircraft. Rodent populations can be reduced by population management (i.e., use of rodenticides) or by habitat management (i.e., vegetation and land-use management) that reduces the area's carrying capacity for rodents. I found that zinc phosphide-treated oats reduced rodent populations by $\geq 94\%$ at the Kansas City International Airport in summer 1999. Raptor strikes at the airport declined after rodenticide use. I also found that some habitat types (soybean and corn fields, cattle grazing) and short grass heights supported fewer rodents than medium grass height areas.

Key words: airport, habitat management, human–wildlife conflicts, IPM, rodent, rodenticide, wildlife damage, zinc phosphide

WORLDWIDE, RODENTS are a major vertebrate pest group because of their impacts on human society. Much effort has been, and continues to be, expended to reduce rodent numbers and the damage that they cause (Witmer 2007, Witmer and Singleton 2010). Rodents are implicated in many types of damage, including damage to crops, trees, structures, and cables, as well as disease transmission, and significant depredation on native species of animals and plants on islands to which rodents have been accidentally introduced (Angel et al. 2009, Witmer and Singleton 2010). Damage can be especially severe when population densities are high (Witmer and Proulx 2010). At the same time, rodents have many important ecological roles, and most species are not major pests (Witmer and Singleton 2010). Some of the ecological roles include soil mixing and aeration, seed and spore dispersal, influences on plant species composition and abundance, and serving as a prey base for many predatory vertebrates.

Bird strikes are an increasing problem in the United States (Dolbeer and Wright 2009), and it is important to address the risks and ways to reduce them (Blackwell et al. 2009). Airports often provide good year-round habitat for rodent populations. Rodents at airports can cause damage directly by their gnawing and burrowing activities. Larger rodents (e.g., beavers [*Castor canadensis*]; porcupines [*Erethizon dorsatum*]; and woodchucks [*Marmota* spp.]) pose a direct collision hazard to aircraft. It

should be noted, however, that larger mammals, such as white-tailed deer (*Odocoileus virginianus*) and coyotes (*Canis latrans*), are considered a much more serious direct aircraft strike hazard than are rodents or other mammals (Dolbeer et al. 2000, DeVault et al. 2008). Perhaps the most serious hazard posed by a sizeable rodent population at airports, however, is the indirect hazard of attracting foraging raptors with an associated raptor–aircraft strike hazard (Barras and Seamans 2002, Blackwell and Wright 2006). Raptors pose one of the most hazardous groups of birds at the airports (Cleary et al. 2002). Unfortunately, many activities at airports result in good habitat for rodents (e.g., allowing tall grass in an effort to reduce loafing habitat for flocking birds) or reduced predation of rodents (e.g., perch removal, bird hazing, carnivore-proof perimeter fencing, and raptor and carnivore capture and relocation; see discussion by Barras and Seamans [2002]). Clearly, it is important to know which rodent species occur at the airport and to have a good understanding of their biology, population dynamics, and ecology, along with their relationships to damage, land uses, and human activities.

In this study, I determined the efficacy of a zinc phosphide-oats rodenticide bait application for rodent populations in a commercial airport. I also monitored rodent populations in different habitat types. My objective was to identify methods or habitat types that might benefit or adversely affect rodent populations and, hence, influence the potential for raptor–aircraft collisions.

Study area and methods

I conducted this study during 1999 to 2002 at the Kansas City International Airport (KCI), Kansas City, Missouri. KCI was a Federal Aviation Administration (FAA)-certified commercial airport. The land within the 2-m-high chain-link perimeter fence consisted of 945 ha covered by buildings, pavement, and expansive grassy areas. Grassy areas contained numerous native and non-native species of grasses and forbs that generally were mowed to ≤ 25 cm in height to increase visibility and to reduce wildlife habitat. The most common grasses were fescues (*Festuca* spp.) and bluegrasses (*Poa* spp.). The airport also owned about 2,855 ha of land outside the perimeter fence, much of which was leased to private parties and used for crop production (e.g., hay, corn, soybeans) and livestock grazing. Trees and shrubs were rare within the airport perimeter fence, but some patches occurred just outside the fence.

Bird strikes at KCI were reported to airport operations by aircraft pilots, crew, and airport grounds personnel. Bird species or taxonomic grouping was determined by visual inspection using morphological characteristics, such as mass, beak, feet, feathers (e.g., FAA 2004). Since 2000, feathers were sent to the Smithsonian Institution for species identification.

In late July 1999, I conducted rodenticide efficacy trials with zinc phosphide-treated rolled oats (2% active ingredient; U.S. Environmental Protection Agency [EPA] concentrate registration number 56228-6). I used a Vicon seed spreader to apply untreated oats (pre-baiting) 3 days before rodenticide baiting. The same seed spreader was used to apply the rodenticide bait to the treated area at the application rate of 7 to 11 kg/ha (EPA approved rate). In 1999, 6,000 kg of rodenticide bait was applied to 790 ha of airport grassland. The same treatment was repeated in 2001.

I determined rodenticide efficacy by assessing prairie voles (*Microtus ochrogaster*) and deer mice (*Peromyscus maniculatus*) captures (both species numbers combined) 3 days after rodenticide baiting using 2 methods: live traps (H. B. Sherman Traps, Tallahassee, Fla.) and snap traps (Woodstream Corp., Lititz, Penn.). Five live-trap grids (each with 100 traps in 10 rows and columns with 10-m spacing between

traps) were established in the southwestern area of the airport. Three grids were in an area to receive rodenticide baiting and 2 grids were in an area not to be baited (untreated plots). To assess the change in rodent numbers that might occur over the course of the study without regard to rodenticide baiting, we monitored rodent populations in the later 2 grids (area not to be treated) at the start of the study and again when the rodent population was being monitored on the treated area after rodenticide application.

Additionally, 6 snap trap grids (each with 25 traps in 5 rows and 5 columns with 10-m spacing between traps) were established in the southwestern area of the airport. Three grids were in an area to be baited with rodenticide, and 3 grids were in an area not to be baited (untreated plots). There were ≥ 40 m between grids in the treated area and between grids in the untreated areas. Additionally, the treated area with grids was about 250 m from the untreated area grids. I assumed that small mammals, such as mice and voles, were unlikely to move that distance over the course of the few days of trapping before and after the rodenticide application period.

Traps were operated for 3 consecutive nights after baiting operations. Traps were baited with a mixture of peanut butter and rolled oats. Traps were set in the late afternoon and checked the next morning. In the case of live traps, rodents were released near the site of capture; hence, recaptures occurred, and the numbers of rodents caught with live traps was always higher than those caught in snap traps. Traps were not operated during the day. Total captures were recorded by grid each day for the 3 consecutive days.

We collected data on habitat use by rodents during August 2001 to 2002 using grids of 5×5 snap traps as described above. Rodent capture data were collected on each of 5 habitat types (2 grids per type) in medium (about 25 cm)-height grass areas that is considered normal airport grass management areas, short grass (10 to 12 cm) areas, and areas outside the perimeter fence in corn, soybean, and livestock-grazed areas. I analyzed the data using Statistix Version 9 (Analytical Software, Tallahassee, Fla.). *T*-tests and ANOVA tests were used to compare captures and capture rates in rodenticide-

treated areas versus untreated areas and among habitat types. With a significant ANOVA test, I used Tukeys’s all-comparisons test to compare individual variables. With statistical analyses, I considered significance to be at $P \leq 0.05$.

Results

In the untreated area, 70 small mammals (11.7 per 100 trap-nights) were captured in live traps during the before-treatment period, while 297 (49.5 per 100 trap-nights) were captured during the after treatment period. This 424% increase in captures may have resulted from increased surface activity by newly-weaned young animals. On the treatment area, 105 small mammals (11.7 per 100 trap-nights) were captured in live traps in the before-treatment period, while 97 (10.8 per 100 trap-nights) were captured in the after-treatment period.

We captured mostly voles (54%), followed by deer mice (36%; Table 1). We also captured a few western harvest mice (2%; *Reithrodontomys megalotis*), southern bog lemmings (<1%, *Synaptomys cooperi*), house mice (<1%; *Mus musculus*), cotton rats (<1%; *Sigmodon hispidus*), and shrews (7%; *Blarina hylophaga* and *Cryptotis parva*). These latter species comprised only about 10% of the total captures. Live trap results showed significantly fewer ($t = 3.43, P = 0.04$) vole and deer mouse total captures over 3 nights on treated grids ($n = 3$) than on untreated grids ($n = 2$). This represented a 96% reduction in their population after the application of rodenticide bait. Snap trap results also showed significantly fewer ($t = 5.59, P = 0.005$) vole and deer mouse total captures over 3 nights on treated grids ($n = 3$) than on untreated grids ($n = 3$). This represented a 94% reduction in rodent population after the application of rodenticide bait.

Data on raptor-aircraft strikes at the airport from 1997 to 2002 were provided by KCI (B. Johnson, KCI airport operations, unpublished data). They showed an increasing trend in

Table 1. Total vole and deer mouse (combined) captures after rodenticide application on treated and untreated grassy areas, Kansas City International Airport, Missouri, July–August, 1999.

Grid	Live-trap captures		Snap-trap captures	
	Treated	Untreated	Treated	Untreated
1	29	90	1	11
2	6	181	1	15
3	10	N/A	0	20

N/A = not applicable; only 2 grids in this category.

Table 2. Vole and deer mice (combined) captures per 100 trap nights, by habitat type, Kansas City International Airport, Missouri, 2000–2002.

Grid (Year)	Medium grass	Short grass	Soybean	Corn	Grazed
1 (2000)	22.6	8.0	N/A	N/A	5.3
2 (2000)	14.6	1.3	N/A	N/A	1.3
1 (2001)	2.7	N/A	2.7	5.3	0.0
2 (2001)	12.0	N/A	2.7	4.0	1.3
1 (2002)	20.0	N/A	12.0	9.3	10.6
2 (2002)	22.6	N/A	16.0	13.3	5.3

N/A = not applicable; data on that habitat type were not collected that year.

strikes through 1999, and then a decline each year thereafter (Figure 1). The first zinc phosphide rodenticide baiting operation was in 1999 and may have been responsible, in least in part, for the decline. Rodenticide baiting was discontinued in 2003 because of state permit and license requirements, after which time strikes began to again increase (B. Johnson, KCI airport operations, personal communication).

The types of habitat outside the perimeter fence of the airport revealed differences in rodent numbers (Table 2). In 2002, capture rates (animals per 100 trap-nights) were lower on soybean grids ($n = 2$) and corn field grids ($n = 2$) than the medium-grass field grids ($n = 2$), but only grazed area grids ($n = 2$) had significantly lower capture rates ($F = 7.71, P = 0.03$) based on the Turkey’s all-pairwise comparisons test. Habitat data collected in 2001 showed similar trends in rodent capture rates by land use, but the results were not significant ($F = 1.45, P = 0.35$), possibly because many fewer rodents were captured which may resulted from the substantial rains during 2 of the 3 night

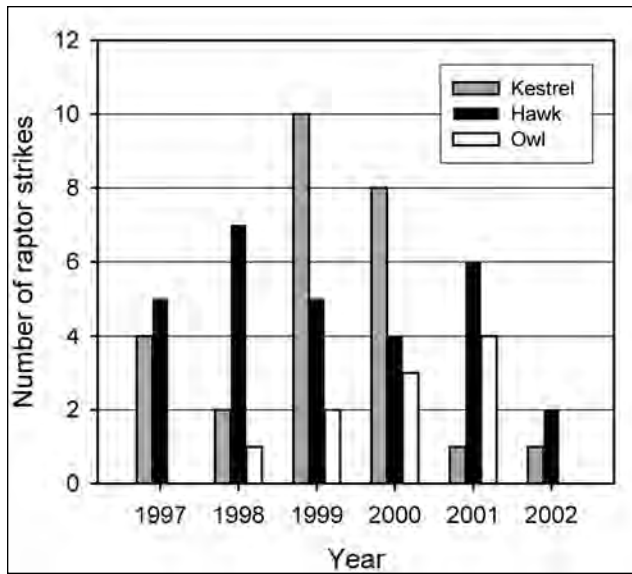


Figure 1. Historical raptor strikes, Kansas City International Airport. Zinc phosphide on grain rodenticide baiting began in summer 1999. (Data courtesy B. Johnson, Airport Operations)

trapping periods (Table 2). Within the airport perimeter fence, rodent capture rates (animals per 100 trap-nights) were significantly lower ($t = 4.63$, $P = 0.04$) on short grass grids ($n = 2$) than on medium-height grass grids ($n = 2$).

Discussion

This study has shown that broadcast baiting with zinc phosphide (2% active ingredient) on oats has worked well for rodent control at the Kansas City International Airport. Similar results have occurred at Whiteman Air Force Base, Missouri (T. Stewart, Wildlife Services, Whiteman (Missouri) Air Force Base, unpublished data). In contrast, zinc phosphide baiting at Portland International Airport, Oregon, did not effectively control rodent populations (S. Gordon, Portland [Oregon] International Airport, airport operations, unpublished data) suggesting that results may differ among airports. In general, rodenticide bait should be applied early in the year, during a dry period, and pre-baiting with untreated oats (or wheat) should be conducted to ensure sufficient bait acceptance. Pre-baiting with untreated grain helps to avoid the development of bait shyness, whereby rodents consume a sublethal dose, become sick, and avoid future bait consumption (Witmer and Eisemann 2007). Zinc phosphide poses a primary hazard to any

animal that consumes it, so, it should be used carefully, and measures should be taken to reduce the potential for nontarget hazards (Witmer and Eisemann 2007). On the other hand, zinc phosphide is considered to pose very low secondary hazards (to scavengers or predators) because it disperses quickly as phosphide gas and does not bio-accumulate (Johnson and Fagerstone 1994). Airport personnel or contractors may wish to consider establishment of a rodenticide program to control rodent populations. An effective program would provide an available tool for a proactive response to an irrupting rodent population, as determined by the population monitoring protocol.

This study has also shown that vegetation management and the use of select land uses can also reduce the

habitat potential to support rodents. Grass height can be managed with an appropriate mowing schedule. Other researchers have shown that rodent population densities are generally lower when vegetation height is maintained at ≤ 20 cm (Allen 1998, Barras et al. 2000, Seamans et al. 2007, Washburn and Seamans 2007). However, mowing produces plant residues (i.e., cuttings or thatch), which can provide cover, travel corridors, and insulating nest materials for rodents (e.g., Peles and Barrett 1996). Hence, consideration should be given to removal of plant residues after mowing. Additionally, tall grass may dampen the amplitude of population cycles observed with mice, resulting in relatively high numbers being maintained year-round (Getz and Hoffman 1999). Tall grass can also allow small, resident populations to build up rapidly (Birney et al. 1976). Even with mowing, vole populations have quickly increased to pre-mowing levels (Edge et al. 1995). Another consideration is that mowing (or certain land uses) outside the perimeter fence may result in an influx of rodents into airport property within the fence if better food and cover exists there. Finally, while higher densities of rodents occur in taller grass, that does not necessarily translate directly into an increased attractant to raptors because the rodents are presumably less detectable and harder to prey upon in tall grass than in short grass.

Grass or vegetation type is also an important consideration. Certain types of grass (e.g., bluegrass, creeping fescue) appear to be less supportive of rodents than other types, such as tall fescue (Sullivan and Vandenberg 2000). Some varieties of rye and fescue grasses, called endophytic grasses, contain an alkaloid-producing fungus that can improve the hardiness of the grass and reduce herbivory (e.g., Washburn et al. 2007). Some studies found that endophytic grass fields support lower rodent densities (Pelton et al. 1991; Witmer, unpublished data). Other species of plants may be unpalatable to rodents. For example, trials are being conducted at the Portland International Airport (Oregon) with a plant called meadowfoam (*Limnanthes alba*) to assess its natural repellency to wildlife (S. Gordon, Portland (Oregon) International Airport, personal communication). Linnell et al. (2009) reported the planting of low-growing wedelia (*Wedelia trilobata*) at tropical airports resulted in lower biomass of invertebrates and a lower number of rodents, both potential food sources for birds. With any of these approaches, it is important to maintain nearly a monoculture of the plant type to prevent the availability of an alternative food source. Grasslands at airports typically are neglected, except for mowing, so, extra effort and expense would be required to maintain monocultures. Artificial turf has even been suggested as a way to restrict rodent habitat, but in most situations, this approach may be prohibitively expensive.

Airport land use outside the perimeter fence should be managed so that it does not support large populations of rodents. Of course, any of the above vegetation management approaches could be implemented on lands managed by the airport outside the perimeter fence. Additionally, cereal grains (e.g., wheat, oats, barley) should not be grown, as these crops support rodents as well as grain-eating birds (Barras and Seamans 2002). The current study has shown that certain crops, such as soybeans and corn, are much less supportive of rodent populations. On the other hand, corn and soybean fields may attract other hazardous mammals and birds (e.g., DeVault et al. 2007). This study has also shown that livestock grazing reduces rodent populations. Moser and Witmer (2000) found similar results on rangelands used by livestock and wintering elk (*Cervus elaphus*) in northeastern Oregon.

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Literature cited

- Allen, J. K. 1998. Small mammal abundance and raptor presence on John F. Kennedy International Airport. Thesis, Montclair State University, Montclair, New Jersey, USA.
- Angel, A., R. M. Wanless, and J. Cooper. 2009. Review of impacts of the introduced house mice on islands in the southern ocean: are mice the equivalent of rats? *Biological Invasions* 11:1734–1754.
- Baker, J. A., and R. J. Brooks. 1981. Raptor and vole populations at an airport. *Journal of Wildlife Management* 45:390–396.
- Barras, S. C., 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, 1998–1999. *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.
- Birney, E. C., W. E. Grant, and D. D. Baird. 1976. Importance of vegetative cover to cycles of microtus populations. *Ecology* 57:1043–1051.
- Blackwell, B. F., T. L. DeVault, E. Fernández-Jurcic, 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., and S. E. Wright. 2006. Collisions of red-tailed hawks (*Buteo jamaicensis*) turkey (*Cathartes aura*), and black vultures (*Coragyps atratus*) with aircraft: implications for bird-strike reduction. *Journal of Raptor Research* 40:76–80.

- Cleary, E. C., S. E. Wright, and R. A. Dolbeer. 2002. Wildlife strikes to civil aircraft in the United States, 1990–2000. Federal Aviation Administration, Washington, D.C., USA.
- DeVault, T. L., J. C. Beasley, L. A. Humberg, B. J. MacGowan, M. I. Reteamosa, and O. E. Rhodes. 2007. Intrafield patterns of wildlife damage to corn and soybeans in northern Indiana. *Human–Wildlife Conflicts* 1:205–213.
- DeVault, T. L., J. E. Kubel, D. J. Glista, and O. E. Rhodes. 2008. Mammalian hazards at small airports in Indiana: impact of perimeter fencing. *Human–Wildlife Conflicts* 2:240–247.
- Dolbeer, R. A., and S. E. Wright. 2009. Safety management systems: how useful will the FAA National Wildlife Strike Database be? *Human–Wildlife Conflicts* 1:97–105.
- 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.
- Federal Aviation Administration (FAA). 2004. Reporting wildlife aircraft strikes. Federal Aviation Administration, Advisory Circular No. 150/5200-32A. Washington, D.C., USA.
- Getz, L. L., and J. E. Hofmann. 1999. Diversity and stability of small mammals in tall grass prairie habitat in central Illinois, USA. *Oikos* 85:356–363.
- Johnson, G. D., and K. A. Fagerstone. 1994. Primary and secondary hazards of zinc phosphide to nontarget wildlife—a review of the literature. USDA/APHIS, Denver (National) Wildlife Research Center, Research Report No. 11-55-005. Fort Collins, Colorado, USA.
- Linnell, M. A., M. R. Conover, and T. J. Ohashi. 2009. Using wedelia as ground cover on tropical airports to reduce bird activity. *Human–Wildlife Conflicts* 1:226–236.
- Moser, B. W., and G. W. Witmer. 2000. The effects of elk and cattle foraging on the vegetation, birds, and small mammals of the Bridge Creek Wildlife Area, Oregon. *International Biodeterioration and Biodegradation* 45:151–157.
- Peles, J. D., and G. W. Barrett. 1996. Effects of vegetative cover on the population dynamics of meadow voles. *Journal of Mammalogy* 77:857–869.
- Pelton, M. R., H. Fribourg, J. Landre, and T. Reynolds. 1991. Preliminary assessment of small wild mammal populations in tall fescue habitats. *Tenn. Farm and Home Sciences* 160:68–71.
- Seamans, T. W., S. C. Barras, G. E. Bernhardt, B. F. Blackwell, and J. D. Cepek. 2007. Comparison of 2 vegetation-height management practices for wildlife control at airports. *Human–Wildlife Conflicts* 1:97–105.
- Sullivan, W. T., and J. G. Vandenberg. 2000. A comparison of grass covers and meadow vole populations in North Carolina. *Proceedings of the Wildlife Damage Management Conference* 9:300–306.
- Washburn, B. E., S. C. Barras, and T. W. Seamans. 2007. Foraging preferences of captive Canada geese related to turfgrass mixtures. *Human–Wildlife Conflicts* 1:214–223.
- Washburn, B. E., and T. W. Seamans. 2007. Wildlife responses to vegetation height management in cool-season grasslands. *Rangeland Ecology and Management* 60:319–323.
- Witmer, G. W. 2007. The ecology of vertebrate pests and integrated pest management (IMP). Pages 393–410 in M. Kogan and P. Jepson, editors. *Perspectives in ecological theory and integrated pest management*. Cambridge University Press, Cambridge, United Kingdom.
- Witmer, G. W., and J. D. Eisemann. 2007. Rodenticide use in the United States: an overview. *Proceedings of the Wildlife Damage Management Conference* 12:114–118.
- Witmer, G. W., and G. Proulx. 2010. Rodent outbreaks in North America. Pages 253–267 in G. R. Singleton, S. R. Belmain, P. R. Brown, and B. Hardy, editors. *Rodent outbreaks: ecology and management*. IRRI, Los Banos, Philippines.
- Witmer, G. W., and G. R. Singleton. 2010. Sustained agriculture: the need to manage rodent damage. Pages 1–39 in F. Wager editor. *Agricultural Production*. Nova Science Publications, New York, New York, USA.
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GARY W. WITMER (left) visiting an invasive mammal-proof fence in New Zealand (with John Innes [right], biologist with Landcare Research, New Zealand). Gary is a supervisory research wildlife biologist and project leader with the USDA/APHIS/Wildlife Services' National Wildlife Research Center in Fort Collins, Colorado. He received his Ph.D. degree in wildlife science from Oregon State University, his M.S. degree in wildlife ecology from Purdue University, and his M.S. and B.S. degrees in biology from the University of Michigan. His research focuses on resolving human-wildlife conflicts, especially those caused by native and invasive rodents. He has designed successful eradication strategies for invasive rodent species on several islands.