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Habitat Management Approaches for Reducing Wildlife Use of Airfields

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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.

Key Words: aircraft, airport, grass, habitat, habitat management, bird strike, wildlife strike

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INTRODUCTION

Wildlife-aircraft collisions (wildlife strikes) cost civil aviation at least $390 million annually in the USA, 1990-2000 (Cleary et al. 2000), caused the destruction of over 300 aircraft, and killed over 300 people worldwide (Richardson 1994, 1996; Richardson and West 2000; Thorpe 1996, 1998; Dolbeer et al. 2000). Over 34,000 wildlife strikes were reported to the U. S. Federal Aviation Administration (FAA) from 1990-2000 (Cleary et al. 2002). These strikes primarily involved birds (97%), though mammals (2%) and other wildlife were also struck.

Gulls (*Larus* spp.), waterfowl (Anatidae), raptors (hawks and owls), and blackbirds (Icterinae)/starlings (*Sturnus vulgaris*) are presently of most concern at airports (Cleary et al. 2000, Dolbeer et al. 2000). Because 71% of strikes occur under 500 feet altitude (above ground level), the greatest risk of bird strikes during flights occurs near the airport at takeoff or landing (Cleary et al. 2002). Accordingly, habitat management (Barras et al. 2000), direct control (Dolbeer 1986, Dolbeer et al. 1993b), and regulatory efforts (Cleary and Dolbeer 1999) for reducing wildlife strikes have focused on wildlife and their habitats on and near airports.

Habitat management is one component of an integrated approach for reducing wildlife use of airports. Habitat management to reduce conflicts is usually aimed at reducing the attractiveness or carrying capacity of the site for species of concern by reducing the availability of food, water, cover, and loafing sites (Van Vuren 1998). Many habitat management efforts on airports focus on the management of vegetation, which can be used directly by hazardous wildlife or support the invertebrate and small mammal populations upon which the problem species rely (Blokpoel 1976, Baker and Brooks 1981). Habitat management alone may not solve hazardous wildlife problems (Cooper 1998), but it should be a foundation of an airport's wildlife management program (Cleary and Dolbeer 1999). Unfortunately, few replicated field evaluations have been conducted to determine the effectiveness of habitat management for reducing wildlife strikes.

We reviewed literature to summarize the information published on airport attractants and strategies for habitat management on airfields to reduce wildlife strikes. Our objective was to offer objective recommendations for habitat management on airports to reduce wildlife hazards where sufficient data were available and to identify research needs.

AIRFIELD VEGETATION MANAGEMENT

Vegetation Height

Vegetation height management has been proposed as a method for reducing bird use of airport habitats. There are no civil regulations requiring that vegetation be managed at a specific height in North America, but recommendations have ranged from 15-25 cm for civil airports (Transport Canada 1994) to 18-36 cm for military airports (Cleary and Dolbeer 1999). Tall vegetation is thought to interfere with visibility, feeding activity, and ground movements of some birds (Blokpoel 1976, U. S. Department of Transportation 1993, Transport Canada 1994, U. S. Department of Agriculture 1998). Tall vegetation is attractive to large ground-nesting birds and supports large populations of prey including insects and small mammals. Although short vegetation does not provide nesting cover or support large rodent and insect populations, it does provide loafing and feeding areas for gulls and small insectivorous birds (Blokpoel 1976). An optimum intermediate height may reduce attractiveness to birds, although response to vegetation of different heights may differ due to species-specific patterns of habitat use (Solman 1973).

The definitions of tall and short vegetation varied among reports that discussed vegetation height. Short vegetation usually referred to vegetation maintained at or near 5 cm (Mead and Carter 1973, Brough and Bridgman 1980, Buckley and McCarthy 1994). Definitions of tall vegetation have varied from >45 cm (Buckley and McCarthy 1994, considered "un-managed" by Barras et al. 2000) to 15-20 cm or 25 cm (Mead and Carter 1973, Brough and Bridgman 1980, Dekker and van der Zee 1996, Barras et al. 2000), which may be functionally equivalent to the intermediate height recommended for minimizing hazardous birds on airports in early reviews (Solman 1966, 1973).

Although many authors recommend that airports adopt a "tall grass" management strategy, few present data to support these recommendations. Most recommend this strategy in review articles without presenting field data (Wright 1968; Creswell 1988; Blokpoel 1976; Burger 1983; Solman 1970, 1973, 1976; U. S. Department of Transportation 1993; Transport Canada 1994; Dekker and van der Zee 1996; U. S. Department of Agriculture 1998). Some reports tout the effectiveness of this strategy from anecdotal observations and non-replicated studies (Dekker 2000), or present results that may not be ecologically or statistically significant (van Tets 1969, Mead and Carter 1973, Reznick 1984, Dahl 1984). Other studies have presented evidence on a single bird species (e.g., northern lapwings [*Vanellus vanellus*] in Belgium, Heirman 1975) or demonstrated preference for short (5-10 cm) vegetation among multiple bird species on other continents (e.g., the United Kingdom, Brough and Bridgeman 1980), where bird species of concern in the USA were not present (Dekker 2000).

Studies to determine if tall vegetation reduced bird activity at airports in the USA have produced conflicting results. Buckley and McCarthy (1994) suggested that laughing gulls (*Larus atricilla*) preferentially used vegetation managed at 5 cm versus 45 cm. However, Barras et al. (2000) found no difference in bird use (all species) at these heights on the same airport and found that small mammal abundance tripled on un-mowed plots (>45 cm, Barras et al. 2000). Thus, there is a critical need for definitive studies to identify optimum strategies for managing vegetation heights to reduce use of airfield grasslands by hazardous wildlife.

Managing Vegetative Species Composition

Vegetative species composition may also affect the relative attractiveness of airfields for birds and mammals. Austin-Smith and Lewis (1969) proposed the use of different vegetation types with specific characteristics on airports, including: low attraction to birds, small mammals and insects; hardy growth and good survival; good ground coverage; and low fire hazard. Of species evaluated to date, some exhibited reduced attractiveness but were unable to compete with local grasses, requiring extensive use of selective herbicides to maintain a dominant stand (e.g., hawkweed, *Hieracium pilosella*, Smith 1976), or grew only in limited climates (e.g., *Wedelia* spp., Linnell et al. 1997). Differences in the attractiveness and palatability of commonly occurring species have been demonstrated clearly in aviary experiments (e.g., Pochop et al. 1999) for hazardous birds such as Canada geese. However, these results have not been applied in field evaluations to determine if monotypic stands can be established to reduce bird use of airfields.

Tall fescue (*Festuca arundinacea*) is a bunch grass recommended for use on temperate airfields which may be unattractive to wildlife (Mead and Carter 1973). In fact, wildlife managers have recommended that it be eliminated to improve habitat quality for desired bird species (Washburn et al. 2000). This plant is commonly infected with the fungus *Neotyphodium coenophialum*, which may enhance repellency to birds following repeated consumption (Mead and Carter 1973, Conover 1991, Conover and Messmer 1996). Feeding on tall fescue may also have negative impacts on small mammals (Coley et al. 1995, Conover 1998), a primary attractant for predatory birds that may pose a threat to aircraft (Baker and Brooks 1981). Consumption of endophyte-infected fescue can result in delayed sexual maturity (Fortier et al. 2000) and higher mortality rates (Conover 1998) in small mammals, although individuals with prior experience with infected fescue may avoid it (Conover 1998). To date, no published studies have been completed on the efficacy of tall fescue in reducing hazardous wildlife at airports.

Management of Woody Vegetation

Trees, shrubs, and hedgerows are important vegetative habitats for birds on airfields (Solman 1966, 1970; Will 1984; Lefebvre and Mott 1987; Cleary and Dolbeer 1999). Many authors recommend the removal of woody vegetation from airport habitats based on observations of bird use (Solman 1966, Blokpoel 1976, Will 1984, Buckley and McCarthy 1994) or the documented importance of these habitat components to wildlife in other situations (Dolbeer 1984, Cleary and Dolbeer 1999). Infrequent disturbance of grasslands may result in encroachment of woody vegetation (Buckley and McCarthy 1994, Barras et al. 2000), which may enhance small mammal habitats. Trees in ornamental settings or woodlots provide roosting habitats for small, flocking birds such as starlings (Lyon and Caccamise 1981; Dolbeer 1984, 1994; Johnson and Glahn 1994; Cleary and Dolbeer 1999), which have been responsible for fatal accidents (Solman 1970; Thorpe 1996, 1998). However, large birds such as cattle egrets (*Bubulcus ibis*) may also form large flocks, roost in trees, and pose serious strike hazards (Will 1984). Trees also provide cover for deer, which pose the greatest hazard to aircraft when species groups are ranked by damaging strikes (Wright et al. 1998; Dolbeer et al. 2000). Trees also provide nesting sites and perches for hawks and owls (Cleary and Dolbeer 1999), which are commonly struck at airports in the USA (Cleary et al. 2000).

Vegetation Management Impacts on Small Mammals

The impact of vegetation management on small mammal populations has been studied extensively in contexts other than airports. Wilkins and Schmidly (1979) found that small mammal abundance and diversity were positively related to plant diversity and ground coverage. They stated that the least disturbed vegetative communities supported the most diverse plant and small mammal communities. Grimm and Yahner (1988) also found that disturbance of roadside habitats reduced abundance of most species of small mammals, primarily due to decreased vegetation height and density. This effect can be achieved through mowing (Wilkins and Schmidly 1979, Cornely et al. 1983, Grimm and Yahner 1988, Barras et al. 2000), grazing (Cornely et al. 1983), or herbicide application (Clark et al. 1996). In general, these studies support the findings that frequent mowing of vegetation will help minimize small mammal abundance on airports (Barras et al. 2000).

AGRICULTURAL PRODUCTION ON AIRFIELDS

Airports may lease property for agricultural practices to diversify their sources of income. However, some crops are especially attractive to flocking birds (Solman 1966, 1973) and the limited revenue produced for airports may not compensate for bird strike costs. Cultivation and other general agricultural practices often are attractive to birds, regardless of the type of crop established (Blokpoel 1976). However, different hazards are associated with different crops (Transport Canada 1994). Sterner et al. (1984) reported that studies of bird use of agricultural crops at airports were rare, though many reviews considered crops attractants. Sterner et al. (1984) reviewed literature on bird damage and attraction to agriculture in non-aviation settings and found that grain crops (especially corn, oats, rice, sunflower, and wheat) attracted birds throughout the production period, especially blackbirds. Production of cereal grains and sunflowers thus is considered an incompatible land use (Dahl 1984, Transport Canada 1994, Cleary and Dolbeer 1999).

Proximity of agricultural lands to aircraft operations influences the hazard level posed by agriculture (Creswell 1988). The Federal Aviation Administration recommends that agricultural crops be at least 172 m from runway centerlines and 300 m from runway ends (Cleary and Dolbeer 1999). Transport Canada (1994) recommended that agricultural production be conducted no closer than 1200 m from runways. In Europe, Dekker and van der Zee (1996) cited separation distances of greater than 200 m for agricultural practices from runways, with less attractive vegetation established in the intermediate distance.

AIRFIELD STRUCTURES

Removal of woody vegetation from airport habitats has been recommended to reduce perching and roosting by hazardous birds (Solman 1966, Blokpoel 1976, Will 1984, Buckley and McCarthy 1994). However, birds also perch on fences, signs, light fixtures, and ledges at airports. Artificial structures can concentrate the activity of raptors near those structures, given that raptor use of specific areas may be enhanced by installing artificial perches (Stahlecker 1978, Hall et al. 1981, Askham 1990). However, we found no studies documenting efforts to decrease raptor use of habitats through perch exclusion or removal.

Use of airfield perches by blackbirds and starlings may also pose significant hazards, given that these birds are responsible for 5 of the most catastrophic bird strike incidents worldwide (Thorpe 1996, 1998; Cleary and Dolbeer 1999). Field applications for excluding blackbirds and starlings usually involve netting for area protection (Feare and Swannack 1978, Dolbeer 1994, Johnson and Glahn 1994) or vegetation management to reduce roosting areas (Wright 1968, Good and Johnson 1978, Lyon and Caccamise 1981, Dolbeer 1984). Exclusion of small birds from artificial perches may be achieved through placement of strands of wire or specialized barbed products (Lefebvre and Mott 1987) on antennas, signs, ledges or other perching locations (Johnson and Glahn 1994).

RUNWAYS, RAMPS, AND SERVICE AREAS

Airports share many features in common with other urban habitats that may attract wildlife such as large paved areas (taxiways, runways, ramps, parking lots), construction sites, and waste collection areas. Paved areas are attractive loafing sites used by many birds, especially gulls (Blokpoel 1976, Burger 1985, Buckley and McCarthey 1994, Gabrey and Dolbeer 1996). Aside from ensuring that paved areas are graded properly to prevent pooling of rainwater, habitat management is not an option for preventing loafing on paved areas, and wildlife using these areas must be hazed.

Service areas and construction zones can be sources of anthropogenic foods (Blokpoel 1976, Cleary and Dolbeer 1999). Care should be taken to ensure that food waste is disposed of in covered bins and workers at service areas and construction sites do not feed wildlife or leave uneaten food behind. The modification of human behavior through the use of education and regulation is essential for minimizing this important habitat component. Structural modifications, including wire grids and netting, may be used to exclude birds from areas where food is present, though these techniques may not be effective for all species (Blokpoel and Tessier 1992).

WATER SOURCES

Airports may provide fresh water for wildlife in the forms of standing stormwater, wetlands, and artificial basins. Wetlands and other natural water bodies on airports should be removed and their values mitigated offsite (Blokpoel 1976, Cleary and Dolbeer 1999). Aquatic habitats are closely associated with specific wildlife communities that pose special hazards to aircraft. Waterbirds (loons, grebes, albatrosses, pelicans, cormorants, waterfowl, herons, egrets, rails shorebirds, gulls, terns, and kingfishers) were responsible for 48% of reported strikes that involved known species and 67% of damaging strikes, 1990-1999 (Cleary et al. 2000). Waterfowl, especially geese, are of special concern because of their large size and flocking behavior (Cleary et al. 2000). Dolbeer et al. (2000) ranked geese the third most hazardous wildlife species group when damage and effect-on-flight were considered.

Water that accumulates on hard surfaces and low areas after precipitation events may attract birds, especially in marine areas (Burger 1985, Buckley and McCarthy 1994, Gabrey and Dolbeer 1996). Proper grading and drainage of these areas is the ultimate solution for eliminating these temporary attractants, though corrective measures require expensive initial investments. Temporary solutions may include use of repellents such as methyl anthranilate (Dolbeer et al. 1992, Dolbeer et al. 1993a, Belant et al. 1995) or changing the color of water (Lipcius et al. 1980) to reduce its attractiveness.

To reduce non-point source pollution, improve groundwater recharge, and ensure wastewater treatment associated with airport operations, artificial basins are sometimes constructed on or near airports for water retention and detention. These basins attract birds (Cleary and Dolbeer 1999), and access to them by birds should be prevented. Wire-grid systems are effective for excluding gulls (Amling 1980, Blokpoel and Tessier 1984, Steuber et al. 1995, Belant and Ickes 1996), and parallel wires spaced at 6-m intervals were sufficient to exclude Canada geese from basins (Terry 1984). A 3 × 3-ft wire grid may decrease use of the basin by most ducks and geese, but not all species (Terry 1984). Netting has also been used to exclude birds from basins, but maintenance requirements are extreme and this system may be damaged by high winds and degraded by sunlight (Martin et al. 1998). Floating plastic balls may exclude birds from basins (Martin et al. 1998), but start-up costs are high and the balls may present FOD (Foreign object damage) hazards if blown onto an active airport runway or taxiway. Repellents including methyl anthranilate (Dolbeer et al. 1992, Clark and Shah 1993, Dolbeer et al. 1993a, Belant et al. 1995) may also be used to reduce the attractiveness of water in containment basins.

SUMMARY

Habitat management is a long-term component of integrated approaches for reducing wildlife use of airports. Many techniques for managing habitats at airports have been developed, including management of the height and species composition of vegetation and removal of woody vegetation. Techniques have also been developed for reducing the availability of water, perches, and other important habitat components. However, 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. Specific needs for reliable data include definitive studies of the response of entire bird communities to vegetation height management in the USA, field evaluations of vegetation types thought to be unattractive to wildlife under operational airport conditions, and techniques for excluding birds from artificial perches.

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