

**IMPACTS OF MOWING ON BIRD ABUNDANCE, DISTRIBUTION, AND
HAZARDS TO AIRCRAFT AT WESTOVER AIR RESERVE BASE,
MASSACHUSETTS**

A Thesis Presented

by

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Disclaimer: the views expressed in this thesis are those of the author and do not reflect the official policy or position of the United States government or the Department of Defense.

ABSTRACT

IMPACTS OF MOWING ON BIRD ABUNDANCE, DISTRIBUTION, AND
HAZARDS TO AIRCRAFT AT WESTOVER AIR RESERVE BASE,
MASSACHUSETTS

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Few studies have measured the impacts of mowing on bird use of habitat and the risk of bird collisions with aircraft on North American airfields. The need for this research has increased as airfields become some of the only large contiguous grasslands available to rare migratory birds in some areas. I studied bird abundance, distribution and behaviors at Westover Air Reserve Base, Massachusetts, USA in June and July 2004. I compared my data with bird strike records to discern any patterns associated with mowing of airfield vegetation. There was no difference in total number of birds or species between mowed and unmowed plots adjacent to runways and taxiways. There were more Upland Sandpipers and Eastern Meadowlarks in mowed vegetation and more sparrows (Grasshopper and Savannah) in unmowed vegetation. From 1997 to 2005, swallows were the birds most often struck by aircraft in June and July at Westover, and were also the second most numerous birds in both mowed and unmowed plots. Bird species that pose high Bird/Wildlife Aircraft Strike Hazard (BASH) risk at

Westover included Turkey Vulture, Red-tailed Hawk, Great Blue Heron, and Canada Goose. I did not observe those species in paired plots of mowed or unmowed airfield vegetation adjacent to runways and taxiways at Westover. I opportunistically observed 64 incidents where species that pose high BASH risk were in or adjacent to areas where aircraft operate. Birds struck most frequently at Westover between April 1997 and January 2005 were “swallows”, American Kestrel, Killdeer, Horned Lark, Eastern Meadowlark, and Mourning Dove. Current mowing practices at Westover may have adverse effects on Upland Sandpiper and Grasshopper Sparrow, both state-listed, rare, grassland birds, but may not measurably reduce overall risk to aircraft, given the continued presence of large, high BASH risk species. I recommend methods to reduce threats posed by high-risk species at Westover, and further research to seek ways to reduce adverse effects of mowing on state-listed, rare, migratory species of birds.

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CHAPTER 1

IMPACTS OF MOWING ON BIRD ABUNDANCE, DISTRIBUTION, AND HAZARDS TO AIRCRAFT AT WESTOVER AIR RESERVE BASE, MASSACHUSETTS

Introduction

Aviation authorities are required to manage airfields to minimize the risk of collisions between birds or other wildlife and aircraft (Air Force Instruction [AFI] 91-202 1998; MacKinnon 2001). These collisions are generally referred to as bird strikes. Costs of bird strikes that damage aircraft are measured in human lives, millions of dollars and thousands of hours of repair time (Cleary et al. 2004; Dolbeer et al. 2000; MacKinnon 2001). Damaged planes that crash or whose pilots dump fuel to stay airborne can also do significant damage to property and the environment. Strikes are, of course, usually fatal to the wildlife struck (MacKinnon 2001).

United States Air Force (USAF) installations with flying operations are required to establish a Bird/Wildlife Aircraft Strike Hazard (BASH) program that includes complete documentation of local wildlife hazards, effects on missions, and possible solutions (AFI 91-202 1998). One mandated solution is managing vegetation to discourage bird use of airfields, as vegetation appears to be the feature that most attracts birds to airports (MacKinnon 2001). Vegetation on USAF airfields must be mowed to maintain a uniform height between 7 and 14 inches (17.8 and 35.6 cm) (AFI 91-202 1998). This management requirement is based on the assumptions that this height minimizes seed production that attracts granivorous species, discourages use by flocking species such as geese, gulls and blackbirds (high BASH species), and minimizes habitat quality for small mammals, ground-nesting birds, and insects. These

prey species, in turn, may attract Eastern Coyotes (*Canis latrans*), Red Foxes (*Vulpes fulva*), birds of prey, and flocks of insectivorous birds, such as swallows, that are high BASH threats (AFPAM 91-212 2004, Barras and Seamans 2002).

The USAF requirement to maintain vegetation between 7-14 inches has apparently evolved from Royal Air Force (RAF) and civilian experience in the United Kingdom (UK) using a “Long Grass Management Program” (Seamans et al. 1998). Prior to the 1960s about two-thirds of the recorded birdstrikes in the UK involved three bird species – the Lapwing (*Vanellus vanellus*), Common Gull (*Larus canus*) and Blackheaded Gull (*Larus ridibundus*). Flocks fed or rested only where there was bare earth or mud, or very short (height not reported) or sparse vegetation. Researchers thought that taller vegetation interfered with birds’ ability to see food such as earthworms and other soil invertebrates, and to detect predators or to make social contact with each other (Deacon and Rochard 2000). In the late 1960s, researchers allowed the grass on RAF airfields to grow to between 15 and 20 cm high in strips 100 m either side of the runways. They compared bird numbers on these “long grass” areas with the short-mown grass on the rest of the airfield. Bird numbers in the “long grass” areas were reduced by about two-thirds. Lapwing and small gull numbers were markedly reduced (Deacon and Rochard 2000). Since the 1970s the RAF has maintained grass height at most of their airfields between 15-25+ cm (Dolbeer and Seamans 1997, Deacon and Rochard 2000).

Fifteen cm is too short to deter some target species in the United Kingdom, however. The eye level of species such as Rooks (*Corvus frugilegus*) is well above 15 cm tall grass. Rooks do not need to hunt soil invertebrates by sight, but rather probe or

dig. They are not deterred by 15-25+ cm grass heights, but some airfields reported rooks are deterred by even taller grass (Deacon and Rochard 2000), although actual height was not reported.

Data supporting assumptions about grass height and its relationship to the occurrence of birds at airports in the United States are limited and inconsistent (Barras et al. 2000; Barras and Seamans 2002). A 2 month study in New York in 1985 found that Laughing Gulls (*Larus atricilla*) used airport vegetation mowed to 5 cm more than they used 45 cm tall vegetation (Buckley and McCarthy 1994; Barras and Seamans 2002). A 7 month study done at the same airport 1 July-28 September 1998 and 6 May-28 September 1999 reported more birds of all species in unmowed (34-95 cm) vegetation than in mowed areas (15-43 cm) (Barras et al. 2000; Barras and Seamans 2002), although sample size was very limited. One hundred forty-seven individuals of the 10 species most often struck by aircraft were counted in mowed plots versus 250 in unmowed plots. Mowed plots attracted the same number of species, but different species, as compared to unmowed plots.

Two 1998 studies at airports in Ohio measured bird presence in mowed versus unmowed grass (Seamans et al. 1998). The first study, in July, noted the locations of geese present in six 18.3 x 30.5 m pens where both mowed grass (4-11 cm) and unmowed grass (16-21 cm) were available. The geese were observed over a 9-day period. There was no difference ($p = 0.52$) in number of geese in tall-grass plots compared to short-grass plots. The second study was conducted in 16 grass plots at an airport over a 7-week period from 20 April – 9 June. Eight plots (1.3-5.0 ha, total area 21.3 ha) were designated as tall grass ($\bar{X} = 23.3$ cm high, range 8.9-72.7 cm) and eight

(1.0-6.2 ha, total area 24.9 ha) were mowed, short grass plots (\bar{X} = 14.3 cm high, range 6.3-48.2 cm). The mean number of birds in tall and short grass plots did not differ (p = 0.40). The number of species using the mowed versus unmowed grass was 23 and 22, respectively.

American Kestrels (*Falco sparverius*), Red-shouldered Hawks (*Buteo lineatus*) and Red-tailed Hawks (*Buteo jamaicensis*) in Maryland and Virginia foraged in mowed grassland plots more than in unmowed plots from December 1999-November 2000 (Fitzpatrick 2003). The plots were circular, 72 m diameter (0.41 ha). The plots mowed shortest (10 cm) and most often (6 times per season) had the highest use by raptors despite having less prey than plots mowed 1 or 3 times per season to 20 or 30 cm.

A variety of other factors also limit interpretation of these inconsistent results. Typically, there are no consistent definitions of tall and short vegetation in the relevant literature (Barras and Seamans 2002). Mowed areas may be composed of different vegetative species than adjacent unmowed areas (Buckley and McCarthy 1994; Barras et al. 2000). Mowing activity may itself be an important disturbance factor that affects bird behavior. Some bird species may not tolerate the presence of machines while others may be attracted to seed or insects made more available to them by the mowing. Biologists and airport wildlife management officers continue to debate how to manage grass spaces (MacKinnon 2001).

The issue of grass management at Westover Air Reserve Base (ARB), Chicopee, Massachusetts, USA (Westover, the Base) poses a variety of management challenges. Westover is the home station for a squadron of C-5A Galaxy cargo aircraft which are some of the largest airplanes in the world (Air Force Link 2003). The base includes one

of the largest contiguous grasslands in the New England region of the United States (Moore 2002). Its grasslands provide breeding habitat to New England's largest populations of three rare species: Upland Sandpiper (*Bartramia longicauda*), Grasshopper Sparrow (*Ammodramus savannarum*), and Phyllira Tiger Moth (*Grammia phyllira*). The sandpiper and moth are state-listed as "Endangered" and the sparrow is state-listed as "Threatened" (Mass. Div. Fish. and Wildlife 2006).

Regulations pursuant to the Massachusetts Endangered Species Act make it illegal to kill, harm, or harass, or disrupt the nesting, feeding, breeding or migration behavior of state-listed rare animals (321 CMR 10.00 et seq.; MGL c. 131A). For birds, this protection extends to eggs and chicks. Air Force policy is to provide for the protection and conservation of state-listed species when it is practicable (AFI 32-7064 2004). Although not required by the federal Endangered Species Act (16 U.S.C. 1531-1544), Air Force installations provide conservation measures for species protected by state law when such protection is not in direct conflict with the military mission. When conflicts occur, installations consult with the appropriate state authority to determine if any conservation measures can feasibly be implemented to mitigate impacts (AFI 32-7064 2004). The Air Force consults with the Natural Heritage and Endangered Species Program of the Massachusetts Division of Fisheries and Wildlife concerning management of rare species at Westover.

The federal Migratory Bird Treaty Act (MBTA) (16 USC 701 *et seq.*) prohibits the incidental taking or killing of migratory birds without a permit. Pursuant to a Congressional mandate, the Secretary of the Interior promulgated regulations to exempt the Armed Forces for the MBTA incidental taking of migratory birds during military

readiness activities (U.S. Fish and Wildlife Service 2007). Neither the new regulations nor a 2006 Memorandum of Understanding between the Department of Defense (DOD) and U.S. Fish and Wildlife Service (USFWS) regarding migratory birds addresses the issue of incidental take during airfield mowing (U.S. Department of Defense 2006).

When and where the airfield grass is mowed for aircraft safety can significantly impact the available habitat for, and presumably the abundance and breeding success of, regionally significant, state-protected, migratory species. Airfield mowing at Westover typically starts in early to mid-June and continues into November. Mowing may result in direct mortality of eggs and unfledged young, given the birds' ground-nesting habits.

Upland Sandpipers nest on the ground in vegetation 8-64 cm tall with egg dates from April 23 to June 15 in New York. Their incubation period is 21 to 24 days. Chicks are precocial and leave the nest to forage with their parents within a day of hatching. Their age at first flight is 30 to 31 days (DeGraaf and Yamasaki 2001). They forage in vegetation of various heights and densities, frequently including vegetation \leq 10-15 cm tall (Houston and Bowen 2001). Grasshopper Sparrows, however, require dry grassy areas with tall vegetation for use as song perches. Their egg dates are from about May 27 to August 6 in New York and Vermont. Their incubation period is 12 to 13 days and their nestling period is 9 days. These sparrows often rear a second brood in July or August (DeGraaf and Yamasaki 2001).

Current mowing practices at Westover eliminate from large areas the vertical structure used as song perches, nest and chick cover and foraging habitat. The mowing machines have been modified to raise their cutting height from the normal commercial range to 7 inches. Incubating Upland Sandpiper or Grasshopper Sparrow adults or,

more likely, their eggs or young in or near the nest, may be destroyed mechanically by tractor wheels or mower blades, however (Kershner and Bollinger 1996).

The goal of this study was to evaluate the impacts of mowing on bird abundance and distribution and the potential for bird hazards to aircraft at Westover. My specific objectives were to: 1) compare bird abundance and species richness between mowed and unmowed plots; 2) identify species at Westover with the highest risk for BASH based upon their behaviors and habitat use; 3) describe Westover bird strike data in comparison to data gathered in this study; and 4) develop recommendations for avian habitat management to reduce BASH at Westover.

Study Area

Westover contains approximately 1016 ha of land in Chicopee and Ludlow in northern Hampden County, Massachusetts (Fig. 1). The base is approximately 3.2 km east of the Connecticut River. Westover's topography is relatively flat with occasional small rises and several low wetlands with elevations from 70-76 m Above Sea Level (USDA 1993).

The base is located in an area of the Connecticut River Valley characterized by gently sloping terrain of medium fertile, sandy loams. The majority of the sandy loams are underlain by silty deposits of firm glacial till. This vertical stratification and gentle slope result in good drainage for much of the Base. The subsoil of the north end of Westover is less porous, causing water to be retained in wetland areas (USDA 1993).

The US Fish and Wildlife Service identified Westover as a Special Focus Area with "high" priority within the Silvio O. Conte National Fish and Wildlife Refuge. The Base provides the largest contiguous grassland in the Connecticut River watershed, (>

490 ha) and is inhabited by the largest populations of Upland Sandpipers and Grasshopper Sparrows in the watershed (USFWS 1995).

Westover is an urban/industrial/agricultural environment. Its improved grounds include pavement and other impervious structures, buildings and landscaped areas around buildings, and ball fields (Fig. 2). Westover's semi-improved grounds are areas where periodic grounds maintenance activities occur for operational or aesthetic reasons. Semi-improved grounds are primarily located in the central portion of the Base and consist of runways, taxiways, aircraft parking aprons, and grassy areas between these pavements. The Base has two active runways, Runway 05-23, which is 91.4 m wide by 3170 m long, and Runway 15-33, which is 45.7 m wide by 2149 m long. Unimproved grounds consist of grassland areas, stream beds and banks, wetlands and forested areas (Jenkins 1995). These areas are located in the northern and eastern portions of the Base.

Westover's large, open grasslands are mowed with varying frequency and vary in vegetative composition. Westover's mowing plan calls for vegetation adjacent to and within 300 feet (91.4 m) of runways and taxiways to be cut so as not to exceed an overall average height of 14 inches (36.5 cm) (Moore 2002). This mowed area is 47% of the grasslands contiguous to the runways and taxiways. Mowing dates may vary each year and among parts of the airfield. The grasslands contain over 100 species of plants but large areas are dominated by alien vegetation (Jenkins 1995). The grasslands in the northwestern and southeastern portions of the Base are relatively dry and dominated by native species, especially bunch-forming grasses (Jenkins 1995). These grasslands often have a substantial sedge component that includes both creeping species

(*Carex pensylvanica* and *C. vestita*) and tussock-forming species. Creeping species grow along or beneath the surface of the ground and root at intervals, usually at the nodes (Gleason and Cronquist 1991). The grasslands also contain a fairly diverse herb flora, although native herb species are relatively few (Jenkins 1995). European pasture grasses dominate grasslands in the northeast and central east portions of the Base. They contain more creeping grasses and have fewer shrubs and sedges than the native grasslands (Jenkins 1995).

In my experience, mowing frequency at Westover also varies with the emphasis placed upon airfield vegetation height, the means of estimating average vegetation height in an area, the attention paid to vegetation height by the contractor responsible for accomplishing the work, and attention by the government quality assurance evaluator assigned to monitor that part of the contractor's performance. I was present during the 2002 through 2005 grassland bird nesting seasons. The contractor does not record when areas are mowed. Based upon my data and interviews with the mowing foreman, I estimate that areas to be maintained at an average of 7-14 inches were first mowed starting in mid-May to mid-June. It normally took a month to mow the airfield area and then the cycle would begin again. Faster growing areas were sometimes mowed sooner in the second sequence than they had been in the first. In 2003, three airfield areas where I had research plots were not mowed from 17 June to 13 August. In 2004, nine of my 14 plots were not mowed from 25 June to 30 July.

Westover's grassland habitat also supports populations of small mammals such as the Meadow Vole (*Microtus pennsylvanica*), Northern Short-tailed Shrew (*Blarina brevicauda*) and White-footed Mouse (*Peromyscus leucopus*) (Gilbert 1998). They

attract foraging raptors such as American Kestrels and Red-tailed Hawks and carnivorous mammals including Eastern Coyotes and Red Foxes, which pose BASH-risks to aircraft.

Methods

Bird Use of Mowed and Unmowed Plots

I examined avian species richness and abundance in mowed and unmowed plots by comparing: 1) overall bird abundance between mowed and unmowed plots; 2) species richness between mowed and unmowed plots; and 3) species-specific abundance between mowed and unmowed plots.

I sampled 14 pairs of mowed and unmowed plots to compare avian species diversity and abundance. Plots were 150 feet (46 m) wide by 1,000 feet (305 m) long (Figs. 2, 3). The 14 pairs of plots were randomly located by assigning all potential plot locations a number, writing each number on a slip of paper, and drawing 14 slips from a container. Collectively, the 14 pairs of plots represented 50% of the available length of adjacent mowed and unmowed grasslands along runways and taxiways. I would have preferred to locate all paired plots ≥ 61 m from tree lines because past censuses had shown less grassland birds within that approximate distance to the trees (S.M. Melvin, Mass. Div. Fish. and Wildlife, personal communication). Twelve of my paired plots were entirely ≥ 61 m from tree lines. Sixty m of the southern end of Plot 1 was 46 m from a treeline, and 46 meters of the northern end of Plot 3 was 15 m from a treeline.

I used matched pairs of plots (Lehner 1998) to help control for the effects of spatial and temporal variation in vegetation heights and bird behaviors. This sample design helped to reduce variation between plots caused by inconsistent vegetative

composition of the grasslands around the airfield, flat versus hilly topography, and distance from roads and forest edges (Martin and Bateson 1993).

I censused birds in plots from 25 June through 30 July 2004 after preliminary field observations in summer 2003. This period coincided with a large portion of peak nesting and brood-rearing periods for most breeding birds on Westover. Mowing is initiated in mid- May to early June. Grass height in mowed plots generally ranged between 10-16 inches versus between 16-36 inches in unmowed plots. The entire airfield is mowed after 1 August, which eliminated the possibility of sampling unmowed plots after that date. I censused each pair of plots 6 times with census days normally spaced 6-7 days apart. Exceptions due to schedule conflicts were 4 days between the first and second census efforts for even-numbered plots and 9 days between the last 2 census efforts for odd-numbered plots.

I began each census of a pair of plots at one of the outer 4 corners, where I paused for approximately 1 minute to record any birds initially seen or heard in either plot. Then I walked through each plot lengthwise and recorded all birds seen or heard. I spent about 10 minutes in each plot for a total of about 20 minutes to census each pair of plots. I walked through unmowed plots in a serpentine pattern to increase the likelihood of detecting birds in the taller vegetation. I walked a straight line through mowed plots. Birds seen to fly from one plot to another in a matched pair were noted, but were tallied in the plot where they were first detected. I alternated starting in mowed or unmowed plots. Some plot pairs were adjacent to others. I sampled even and odd numbered plot pairs on different days to minimize problems of independence caused by my flushing of birds from one pair of plots into another.

I identified sparrows to species whenever possible; otherwise they were tallied as “Sparrow.” For statistical analysis I grouped these with Grasshopper Sparrows and Savannah Sparrows as “All Sparrows.” Similarly, it was sometimes difficult to identify all swallows to species when in flight. I grouped, “All Swallows” together for analysis. I grouped other bird species that were present, but in numbers too small for statistical analysis by species, together as “Other Species.”

I used two-tailed, Wilcoxon Matched-Pairs Signed-Ranks tests to compare mean numbers of individuals per plot, mean numbers of species per plot and number of individuals of each species per plot between mowed and unmowed plots (Lehner 1998, IPS statistical software).

Opportunistic Observations of BASH-Risk Species

I recorded numbers of individuals and their locations relative to major habitat types for opportunistic observations (Lehner 1998) of 11 species of birds and 1 species group ("swallows") that pose BASH risks because of large size, flocking behavior, or history of aircraft strikes (Table 1) (Dolbeer et al. 2000, Zakrajsek and Bissonette 2005). All but 3 of these species (Great Blue Heron, Wild Turkey, Northern Harrier) were struck by aircraft at Westover between 1997 and 2005. Birds observed opportunistically were recorded as occurring in or over 1 or more of 3 broad habitat types: "flight-line" (includes surfaces of, and airspace over, runways and taxiways, as well as the airspace extending out from ends of runways to a distance of 1,000 m), "mowed" (mowed grass and other herbaceous vegetation), and "unmowed" (unmowed grass and other herbaceous vegetation). These observations were made between 0655 and 1649 hours Eastern Daylight Time from 22 June through 30 July 2004.

Approximately 90% of observations were made while I was on the airfield traveling to or from, or while near, my sample plots, and the rest were made on other occasions when I was on the airfield. The opportunities for the observations were not evenly distributed over the entire airfield area or between mowed and unmowed areas.

Westover Bird Strike Data

I summarized records of birds that were struck by aircraft at Westover between April 1997 and January 2005. Base operations staff, aircraft maintenance personnel, and biologists with USDA Wildlife Services collect the remains of birds known or suspected to have collided with aircraft at Westover. They use a standard form to record the information known about the strike and enter it into a central Air Force database. They send the remains to the Smithsonian Institution, Washington, D.C. for identification. I excerpted bird strike reports from June and July, 1997 to 2005, and compared them with my census and opportunistic data collected during June and July 2004.

Results

Bird Use of Mowed and Unmowed Plots

Mean number of birds per plot (all species combined) did not differ between mowed ($\bar{X} = 7.3$, range = 0-66) and unmowed ($\bar{X} = 6.2$, range = 0-43) plots ($p = 0.752$) (Table 2). Mean numbers of species in mowed plots ($\bar{X} = 2.3$, range = 0-6) and unmowed plots ($\bar{X} = 2.5$, range = 0-7) did not differ significantly ($p = 0.066$). I found more sparrows ($p < 0.001$) in unmowed plots than in mowed, and more Upland Sandpipers ($p = 0.005$) and Eastern Meadowlarks ($p = 0.001$) in mowed plots than in unmowed (Table 2). Numbers of Bobolinks, Mourning Doves, swallows, or “other

species" did not differ significantly between mowed and unmowed plots ($p > 0.071$) (Table 2).

Opportunistic Observations of BASH-Risk Species

I observed 64 incidents of 9 BASH-risk species and 1 species group ("swallows") on or over the airfield between 23 June and 30 July 2004 (Table 3). The 64 incidents involved a total of 1414 birds. The areas of the 3 principal habitat types available to birds were: airfield pavement- 174 ha (29%), mowed vegetation- 201 ha (34%) and unmowed vegetation- 219 ha (37%). All observations of American Crow, 3 of 4 observations of Turkey Vulture, and 12 of 17 observations of Red-tailed Hawk occurred wholly or partly on or over "flight-line" habitat (i.e. runways, taxiways, or airspace extending off the ends of runways) (Table 3). Twenty of 24 observations of American Kestrels occurred partly in or over mowed habitats, while the other 4 were in both mowed and unmowed areas. I observed more European Starlings (*Sturnus vulgaris*) on paved areas or in mowed areas than in unmowed vegetation. I observed more Mourning Doves in unmowed vegetation than in mowed areas, although I did observe flocks of 25 and 250 doves foraging in areas of cracked pavement and mowed vegetation. Great Blue Herons flew over the runways on 6 occasions on 4 days during my study. The herons did not land on the airfield and appeared to be flying from one wetland to another without regard to the types of habitat below them. The herons built a rookery of 13 nests in 2003. The nests were in dead trees in a swamp that had been inundated by beavers, only 800 m from Westover's main runway. Of the 10 BASH-risk species or species groups, only Red-winged Blackbirds were not observed in or over "flight-line" habitat (Table 3). I saw flocks of Red-winged Blackbirds only in unmowed

vegetation in wetlands on the airfield. I did not observe Canada Geese or Wild Turkeys on the airfield during my study.

I observed one or more birds crossing the main runway (05/23) or its extended flight path 26 times and crossing Runway 15/33 or its extended flight path 7 times. These observations included a flock of 200 starlings that took off from a taxiway near pooled water at the fire training area and crossed the north end of Runway 15/33, a single crow and flocks of 5 and 7 crows that flew across runway 05/23, and 10 observations of Red-tailed Hawks that crossed runways or flight paths in ones or twos. I observed 1 American Kestrel and 1 Red-tailed Hawk perched on lights or equipment < 25 m from runways, 11 kestrels and 3 Red-tailed Hawks perched on equipment or towers 26-50 m from runways, and 1 Red-tailed Hawk perched > 100 m from a runway.

Westover Bird Strike Data

A total of 176+ bird strikes, representing 37+ different species, were recorded at Westover ARB from April 1997 through January 2005 (Table 4). Birds struck most frequently were swallows (≥ 32), American Kestrel (28), Killdeer (20), Horned Lark (14-32), Eastern Meadowlark (13), and Mourning Dove (11). The exact numbers of swallows and Horned Larks struck is uncertain because these species tend to collide with aircraft as flocks and there are times when it is not possible to collect sufficient, recognizable remains to count the numbers of individuals involved. This uncertainty extends to the number of species struck. It was not possible to identify 9 birds during this time period. Single strikes were reported for 19 different species of birds. These included the following species with relatively large body mass that pose high BASH risk: Turkey Vulture, Canada Goose, Mallard, Red-tailed Hawk, and Herring Gull.

A total of 33 bird strikes were reported during June and July, 1997-2005 (Table 4). Birds struck most frequently during those months were Killdeer (8), American Kestrel (7), Rock Dove (4), and Mourning Dove (2). Also struck during those months were 1 Upland Sandpiper, 1 Red-tailed Hawk, and 1 European Starling, but no sparrows.

Discussion

My data did not demonstrate a clear pattern of preference for either mowed or unmowed areas of grasslands adjacent to runways and flight lines at Westover by bird species that pose BASH risk. Mean number of birds per plot did not differ between mowed and unmowed plots, a finding consistent with Seamans et al. (1998), but contrary to the findings of Buckley and McCarthy (1994), Barras et al. (2000), Barras and Seamans (2002), and Fitzpatrick (2003). My findings that mean number of species per plot did not differ significantly ($p < 0.05$) between mowed grass areas near runways and adjacent unmowed areas are consistent with those of Seamans et. al. (1998), Barras et al. (2000), and Barras and Seamans (2002). However, at a confidence level of $p < 0.10$, which may be more appropriate given the relatively small sample size and high variance of plot data, mean number of species per unmowed plot was slightly higher than per mowed plot (2.5 versus 2.3 species per plot). I am not aware of another study consistent with that result.

I found that sparrows were more abundant in unmowed plots, while Upland Sandpipers and Eastern Meadowlarks were more abundant in mowed plots. I am not aware of other research data on comparative use of mowed versus unmowed habitats at

airports by these species. At a confidence level of $p < 0.10$, Mourning Doves were more abundant in mowed plots than in unmowed plots.

Eastern Meadowlark was the fifth most commonly struck species ($n = 13$) and Mourning Dove was the seventh most commonly struck species ($n = 11$) at Westover from April 1997 through January 2005. Further research is needed to determine if Mourning Doves and Eastern Meadowlarks select for shorter, i.e. mowed vegetation, and whether the abundance of shorter vegetation adjacent to runways contributes to the relatively high frequency at which these species are struck by aircraft at Westover (Table 4).

Only 4 sparrows (3 Grasshopper Sparrows, 1 Savannah Sparrow) and 3 shorebirds (including 1 Upland Sandpiper) were struck during that period (Table 4). During June and July, 1997-2004, only 1 meadowlark, 2 Mourning Doves, 1 Upland Sandpiper, and no sparrows were reported struck by aircraft at Westover. Nationwide, sparrows were the third most frequently reported species group (after gulls and "blackbirds-starlings") involved in strikes by civilian aircraft, but seldom caused damage or affected aircraft flight (Dolbeer et. al. 2000). Mourning Doves ranked 13th nationally with a hazard score of 17 out of 100 possible points relative to civilian aircraft.. For military aircraft, Mourning Dove had the 16th highest hazard index (Table 5). Shorebirds of all species combined ranked 17th in frequency of aircraft strikes, but were more likely to cause damage and affect aircraft flight than were sparrows. Shorebirds of all types had a hazard score of only 12 out of 100, sparrows only 4 out of 100, and meadowlark strikes were reported too infrequently to be ranked. However, in a

study of bird hazards to military aircraft, meadowlarks were ranked 12th, "sparrows" were ranked 18th, and shorebirds were ranked 21st (Table 5).

American Kestrel was the species struck by aircraft most frequently at Westover ($n = 28$) (Table 4). However, kestrels score relatively low in terms of hazards to military and civilian aircraft (Table 5). Most (20 of 24) of my observations of kestrels during June-July 2004 were in flight-line or mowed habitats. American Kestrels prefer to forage in complexes of open grasslands that are mowed or otherwise short in height (NRCS 1999). They hunt from perches $\geq 70\%$ of the time (Toland 1987) and also use perches to eat prey, rest, and preen. Kestrels at Westover perched on short lights marking the runway edges and on distance markers located 100 feet from runway edges and within mowed habitats. Kestrel foraging habitat may be improved by periodic mowing to a height of less than 10 inches (25 cm) or by burning (Lane and Fischer 1997, Fitzpatrick 2003). I believe that current mowing practices at Westover may increase the likelihood of kestrel strikes. Kestrels are likely attracted to the vicinity of runways at Westover by the extensive areas of relatively short grass that facilitates their hunting behavior, largely from perches (Toland 1987; Sheffield et al. 2001). While shorter vegetation may support lower prey densities, it may be more attractive to kestrels because it allows them easier access to prey (primarily grasshoppers and small mammals) (Toland 1987; Sheffield et al. 2001). Airport areas at Stuttgart, Germany that had been mowed twice during the summer were more attractive to Common Kestrels (*Falco tinnunculus*) and Rooks (*Corvus frugilegus*) than areas not mowed (Schmid and Matthaus 2005). Areas that had been mowed once or twice also attracted more European Starlings and Common buzzards (*Buteo buteo*) than areas not mowed.

Recommendations for managing habitat to reduce aircraft/kestrel strikes depend upon perceived risk. Actual risk to military and civilian aircraft from kestrel strikes is relatively low, so managers may not believe changes are necessary. Military aviators and managers have low tolerance for any bird strikes, however. Pilots must try to see around any bird remains on their windshield and must deal with the uncertainty that no damage was caused. As a former flight crew member I am aware that hitting anything at approximately 100 miles per hour during take-offs and landings, the critical phases of flight, adds to an already stressful environment.

Managers should study the effect of decreasing the width of mowed areas and further limiting the availability of perches adjacent to runways to reduce kestrel strikes. They have already removed power poles and wires that kestrels, Mourning Doves, Red-winged Blackbirds, and European Starlings used as perches. Workers have also installed physical barriers to discourage birds from perching on airfield lights and signs. Alternatively, I recommend investigating whether mowing areas farthest from the runways, particularly if perches are available there, may attract kestrels away from the runways. Kestrels are usually present at Westover ARB from at least April through October. Collisions between kestrels and aircraft occur throughout that time, with the most strikes from July through September (439 AW/SE 2006). Based upon studies of Turkey Vultures and Red-tailed Hawks, trapping and moving kestrels may be an effective way to reduce their presence and strikes with aircraft (Humphrey et al. 2000; Anderson 2005; Hallett 2005).

A number of tall perches were available to birds and may have influenced their distribution and habitat use on the airfield. Sixteen large buildings (mostly hangars) 15

m or more tall and 3 light towers 25 m tall are present west of the main runway. Some of these towers were within a few meters of mowed vegetation while others were about 200 m from mowed vegetation. Flocks of European Starlings and Mourning Doves roosted on the roofs of hangars adjacent to mowed habitat. Red-tailed Hawks perched on the 25 m light towers and 20-25 m tall antennae on roofs west of the runway. East of the main runway, 6, 4-6 m-high towers provided perches. These were situated in mowed vegetation, but were closer to unmowed vegetation than any of the buildings or tall towers west of the main runway.

I made multiple, opportunistic observations of several high-risk BASH species in or immediately adjacent to areas of aircraft operations during the relatively short time frame of my study. These included Turkey Vultures, Red-tailed Hawks, European Starlings, and "swallows"; these species or species groups ranked 1st, 5th, 4th, and 7th, respectively, in terms of hazards to military aircraft (Zakrajsek and Bissonnette 2005) (Table 6).

I observed Turkey Vultures over the runways during my study and on many other occasions. Frequently ≥ 12 vultures are attracted to the 3 active landfills located ≤ 2 km of the airfield. Vultures typically soar on thermals generated from changes in topography and vegetation and from the runways and taxiways themselves. As of January 2005, Turkey Vultures were the second-leading species for Air Force bird strikes nation-wide by cost (over \$97 million) and 7th by count (496 strikes) (Air Force Safety 2005). In September 2002, an aircraft at Westover was damaged when it struck 2 Turkey Vultures.

Turkey Vultures and gulls attracted to landfills constitute an extremely high threat to aircraft. Given this threat, I recommend that Westover, state and municipal officials work to close active landfills and not approve new ones ≤ 9.7 km of Westover. 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 Municipal Solid Waste Landfill within 6 statute miles (9.7 km) of certain public-use airports (Cleary and Dolbeer 2005). That distance should be applied to closure of active landfills. Meanwhile, the Base invites the 3 landfill operators to report conditions at the landfills at its quarterly Bird Hazard Working Group meetings. The operators make an effort to keep the working faces of the landfills small and cover the food-containing garbage as they go. USDA/APHIS/Wildlife Services biologists provide information to the operators and have dispersed or killed Turkey Vultures present.

Trapping and moving Turkey Vultures may be another effective way to reduce their presence and strikes with aircraft (Humphrey et al. 2000). Pyrotechnics and live ammunition are ineffective in dispersing the vultures when they soar. Fewer ($p < 0.04$) Turkey Vultures used a roost where dead vultures were used as effigies (Seamans 2004). I recommend that Wildlife Services consider using dead vultures as effigies at the area landfills. An innovative technique to disperse the vultures may be the use of miniature, remote controlled airplanes or helicopters to harass them (Carter 2001).

Aircraft at Westover have struck two Red-tailed Hawks since the Base began logging strikes in April 1997. Fortunately neither of those strikes damaged the aircraft. This species ranks ninth in the U.S in both total damage to Air Force aircraft (over \$13 million) and number of strikes (445)(Air Force Safety 2005). Managing this species

involves altering habitat, denying use of perches where practical, and removing transient and hatch-year hawks, while retaining one or more nesting pairs as a stable population of residents (Anderson 2005; Hallett 2005).

Red-tailed Hawks use a wide variety of habitats and prefer, among other things, a matrix of open pasture or swampy areas and wooded habitats (DeGraaf and Yamasaki 2001). This describes the habitat at and near the Base. They require large trees for nesting and perching. The Base contains and is surrounded by large trees, and I observed Red-tailed Hawks perching in trees along the grassland edge. The Base should continue with plans to increase the distance from the tree-line to the aircraft movement areas by converting woods to grassland. Red-tailed Hawks use perches for 60-80% of their hunting (DeGraaf and Yamasaki 2001). I observed them perching on airfield lighting and on equipment towers. Maintenance workers or contractors should discourage or deny these hawks' use of man-made perches by installing strips of spike-like wires or other sharp objects.

Transient or young Red-tailed Hawks may also be trapped and moved successfully (Anderson 2005; Hallett 2005). Leaving resident pairs of these hawks may reduce BASH risk. They learn to avoid aircraft and drive off other hawks to defend their territories (Hallett 2005). Other techniques for managing this species are altering prey habitat and denying use of perches where practical. Examples of the techniques at Westover are removing brush, stumps, and coarse woody debris, reducing the number of trees that produce mast, promoting a monoculture of Little Bluestem (*Schizachyrium scoparium*) grass, moving the tree line away from runways, removing poles and

antennas, and altering the remaining equipment and lights so that birds find it difficult to perch there.

Swallows were the second most numerous species in both mowed and unmowed plots. Although swallows were the species group most frequently struck by aircraft at Westover from April 1997 through January 2005, they were not reported struck during June-July in those years (Table 4). Swallows ranked last of 21 species groups, with a hazard score of only 2 out of 100, as a risk to civilian aircraft (Dolbeer et. al. 2000). However, for military aircraft, swallows had the 7th highest hazard index out of 45 bird species /species groups (Zakrajsek and Bissonette 2005). Biologists have observed flocks of Bank Swallows nesting in sand piles used by local landfill operators to cover refuse (M. Cozine, USDA/Wildlife Services, personal communication). Closing active landfills and not approving new ones ≤ 9.7 km of Westover would help to decrease the prevalence of swallows at the base.

I am uncertain how patterns of mowing and grass heights affect swallow presence. It has been suggested that allowing taller grass heights produces more insect prey, which in turn could attract more swallows to the airfield. But it is uncertain whether fewer swallows are present now in summer than were present when mowing was more restricted in June and July. I have observed flocks of swallows foraging over both short and tall grass at Westover, including lawns (grass height = 4-5 inches). Even with the current, more frequent, mowing regime, flocks of swallows continue to roost on paved areas of the airfield in July and August. It may be that the combination of large, contiguous open areas of pavement and grassland will always attract significant numbers of swallows in summer, regardless of mowing regimes.

I observed Great Blue Herons flying over the runways on 6 occasions on 4 days during my study. The herons did not land on the airfield but simply flew over it from one wetland to another. The herons built a rookery of 13 nests in 2003 in dead trees in a swamp that had been inundated by beavers. The rookery was 800 m from Westover's main runway. Great Blue Heron strikes ranked 47th for Air Force bird strikes by total cost but averaged over \$13,000 per strike (Air Force Safety 2005). I recommend that USDA/Wildlife Services continue to monitor the rookery and report any heron activity to base operations, safety, and natural resources managers at Westover.

I detected few Killdeer in plots, likely due to their relatively low abundance on the airfield combined with the placement of my plots. Killdeer occur most often on or within 50 m of paved areas (personal observation), while my plots were specifically located 50 m from the edges of runways for safety reasons. The tendency of Killdeer to occur on paved areas or in mowed or sparsely vegetated habitats along the edges of pavement is likely the reason why they were the species struck by aircraft second most frequently at Westover (Table 4).

Westover ARB currently supports the largest populations in Massachusetts of 2 state-listed species of grassland-dependent birds, the Upland Sandpiper and Grasshopper Sparrow. A total of 140 adult Upland Sandpipers and 212 singing male Grasshopper Sparrows were tallied during a complete census of the base in June 2005 (S.M. Melvin, Mass. Div. Fish. and Wildlife, unpublished data). Breeding populations of both species increased at Westover during the late 1980's and 1990's, concomitant with a reduction in the extent of mowing on the airfield during the nesting and chick-rearing periods in those years. From 1986 until the late 1990's, mowing did not occur

on the airfield between May 1 and July 31 each year except along 50 foot-wide strips immediately adjacent to runways and taxiways that were kept mowed to a height of roughly 6-10 inches. These mowing restrictions were adopted in part based on recommendations from Massachusetts Division of Fisheries and Wildlife, as a means to both benefit rare grassland birds and discourage use of the airfield by flocks of high BASH-risk species such as gulls, geese, ducks, crows, and starlings, and in part based on the desire of the Base to reduce annual mowing costs (S.M. Melvin, Mass. Div. Fish. and Wildlife, personal communication).

Since the late 1990's, the extent of areas mowed one or more times between May 1 and July 31 has gradually increased, based on recommendations from USDA-Wildlife Services and, more recently, the USAF BASH team. Since 2000, approximately 47% of the grassland area on the airfield has been mowed 2 or more times between May and July with the goal of maintaining an average height of 7-14 inches throughout the growing season (Fig. 2; Moore 2002). These areas of the airfield are mowed at least once, and sometimes twice, between May 1 and July 31, usually beginning in early June. This increased extent and frequency of mowing during June and July may have resulted in increased direct mortality of both Upland Sandpipers and Grasshopper Sparrows, through crushing of eggs, direct injury to chicks and adults caused by mower blades, possible abandonment of eggs or chicks, and exposure of eggs and unfledged chicks to predators. Also, recently mowed areas may be avoided by Grasshopper Sparrows seeking to feed or nest. However, it is debatable whether the current strategy of more extensive and frequent mowing actually reduces overall BASH risk to aircraft at Westover, given that Turkey Vultures, Great Blue Herons, Red-tailed

Hawks, and waterfowl are much more serious threats and remain present despite the mowing. Further, expanding the width of short grass areas along runways may have actually increased the attractiveness of these areas to species such as American Kestrel, which was observed most frequently in mowed areas.

More research is needed to determine if current mowing regimes can be fine-tuned to reduce adverse effects to rare grassland birds, without increasing, and perhaps even reducing, BASH risk. Options for experimentation include: 1) modifying the timing of mowing, for example delaying until early July, in order to minimize direct mortality of eggs and chicks, 2) reducing the areal extent of mowing in June and July, both to reduce the number of nests and broods that may be affected, and possibly to discourage use of short-grass near runways by species such as American Kestrel, 3) using sickle-bar mowers or other equipment to reduce mower wheel “footprints”, 4) using chemicals to inhibit vegetative growth, and 5) planting vegetation that does not require mowing.

The research should include a detailed study of the nesting and chick-rearing phenology and reproductive success of both Upland Sandpipers and Grasshopper Sparrows at Westover, and quantification of the effects of current mowing practices on reproductive success of both species. Data from these investigations could then be used to predict both 1) long-term impacts of current mowing practices on breeding populations of both species at Westover, and 2) effects that adjustments in the timing and extent of mowing would likely have on these populations and their reproductive success. Vegetation proposed for use on the airfield to reduce or eliminate mowing must not attract BASH species, should be native to the region, and should not require

expensive care. Some candidates include Red Fescue (*Festuca rubra*) and Pennsylvania Sedge (*Carex pennsylvanica*).

Table 1. BASH-risk avian species observed opportunistically at Westover ARB, MA, 2004.

Species	Large body	Flocks	Strike history	Hazard rank ^a
American Crow	X	X		20
American Kestrel			X	20
Canada Goose	X	X		2
European Starling		X		4
Great Blue Heron	X			14
Mourning Dove		X	X	16
Northern Harrier	X			b
Red-tailed Hawk	X			5
Red-winged Blackbird		X		4
“Swallow”		X	X	7
Turkey Vulture	X			1
Wild Turkey	X			b

^a Zakrajsek and Bissonette 2005

^b unranked

Table 2. Mean number of birds or species in mowed and unmowed plots, Westover ARB, 2004.

Species	Plots	Mean	Range	S.E.	<i>T</i>	n	p
No. of Individuals	Mowed	7.3	0-66	1.12			
	Unmowed	6.2	0-43	0.71	1188	70	0.752
Mourning Dove	Mowed	2.1	0-60	0.94			
	Unmowed	0.3	0-9	0.13	38	17	0.071
“Swallow”	Mowed	2.0	0-15	0.32			
	Unmowed	1.7	0-10	0.25	168.5	30	0.192
“Sparrow”	Mowed	1.6	0-8	0.2			
	Unmowed	3.2	0-33	0.45	396	64	< 0.001
Meadowlark	Mowed	0.8	0-12	0.19			
	Unmowed	0.2	0-2	0.05	37.5	6	0.001
Other birds ^a	Mowed	0.6	0-28	0.34			
	Unmowed	0.4	0-9	0.14	110	21	0.862
Upland Sandpiper	Mowed	0.3	0-3	0.07			
	Unmowed	0.1	0-1	0.03	10	14	0.005
Bobolink	Mowed	0.1	0-4	0.07			
	Unmowed	0.3	0-7	0.11	20.5	11	0.278
No. of species	Mowed	2.3	0-6	0.16			
	Unmowed	2.5	0-7	0.16	408	48	0.066

^a These include the following species: American Crow, American Kestrel, Eastern Kingbird, European Starling, Horned Lark, and Killdeer.

Table 3. Numbers of individuals of BASH-risk bird species observed opportunistically in 1 or more of 3 broad habitat types at Westover ARB, MA, June-July 2004

Species	Hazard Rank ^b	Habitat types ^a								Total
		Flightline	Flightline, mowed	Flightline, mowed, unmowed	Flightline, unmowed	Mowed	Mowed, unmowed	Unmowed		
Turkey Vulture	1	1	1	1	0	0	0	1	1	4
European Starling	4	200	0	0	50	150	0	30	0	430
Blackbird	4	0	0	0	0	0	0	60	0	60
Red-tailed hawk	5	3	0	7	6	1	0	0	0	17
“Swallows”	7	91	51	1	0	10	0	40	0	193
Great Blue Heron	14	1	1	4	0	0	0	0	0	6
Mourning Dove	16	25	15	2	0	81	321	222	0	666
American Crow	20	5	1	7	0	0	0	0	0	13
American Kestrel	20	0	7	0	0	13	4	0	0	24
Northern Harrier	^c	0	0	0	0	1	0	0	0	1
Total Birds		326	76	22	56	256	325	353	0	1414

^a Flightline: runways, taxiways, the airspace over them and extending from ends of runways to a distance of 1,000 m. Mowed: vegetation adjacent to runways and taxiways is mowed so as not to exceed an overall height of 14 inches. Unmowed: vegetation beyond 300 ft from runways and taxiways is mowed after 31 July to provide breeding habitat for rare birds.

^b Zakrajsek and Bissonette 2005

^c unranked

Table 4. Birds struck by aircraft at Westover ARB, MA April 1997- January 2005, and during months of June and July 1997-2004.

Common name	Species	Number of individuals	
		All months	June-July
All Swallows ^a	<i>Hirundininae</i>	32+	^b
American Kestrel	<i>Falco sparverius</i>	28	7
Killdeer	<i>Charadrius vociferous</i>	20	8
Horned Lark	<i>Eremophila alpestris</i>	14-32	1
Eastern Meadowlark	<i>Sturnella magna</i>	13	1
Perching Birds	<i>Order Passeriformes</i>	12	1
Mourning Dove	<i>Zenaida macroura</i>	11	2
Unidentified	<i>Insufficient remains</i>	9	3
Rock Dove	<i>Columba livia</i>	5	4
Chimney Swift	<i>Chaetura pelagica</i>	3	1
Grasshopper Sparrow	<i>Ammodramus savannarum</i>	3	
Common Snipe	<i>Gallinago gallinago</i>	2	1
Common Nighthawk	<i>Chordellas minor</i>	2	
Blue Jay	<i>Cyanocitta cristata</i>	2	
Canada Goose	<i>Branta canadensis</i>	1	
Mallard	<i>Anas platyrhynchos</i>	1	
Turkey Vulture	<i>Cathartes aura</i>	1	
Red-tailed Hawk	<i>Buteo jamaicensis</i>	1	1
Peregrine Falcon	<i>Falco peregrinus</i>	1	
Semipalmated Plover	<i>Charadrius semipalmatus</i>	1	
Spotted Sandpiper	<i>Actitis macularius</i>	1	
Upland Sandpiper	<i>Bartramia longicauda</i>	1	1
Herring Gull	<i>Larus argentatus</i>	1	
Great Horned Owl	<i>Bubo virginianus</i>	1	
Northern Flicker	<i>Colaptes auratus</i>	1	
Acadian Flycatcher	<i>Empidonox virescens</i>	1	
American Crow	<i>Corvus brachyrhynchos</i>	1	1
Thrushes and Forktails	<i>Family Turdidae</i>	1	
Swainson's Thrush	<i>Catharus ustulatus</i>	1	
European Starling	<i>Sturnus vulgaris</i>	1	1
American Pipit	<i>Anthus rubescens</i>	1	
Common Yellowthroat	<i>Geothlypis trichas</i>	1	
Savannah Sparrow	<i>Passerculus Sandwichensis</i>	1	
Red-winged Blackbird	<i>Agelaius phoeniceus</i>	1	
Total		176	33

^a Purple Martin (*Progne subis*), Tree Swallow (*Tachycinetta bicolor*), Bank Swallow (*Riparia riparia*), Cliff Swallow (*Petrochelidon pyrrhonota*), Barn Swallow (*Hirundo rustica*)

^b Blanks represent zeros.

Table 5. Hazard ranks for bird species that pose BASH-risk at Westover ARB, MA.

Species group	Military		Civilian		Number struck 1997-2005 ^c
	Hazard score	(rank) ^a	Hazard index	(rank) ^b	
Turkey Vulture	127.9	1	63	2	1
Geese	76.1	2	52	3	1
Blackbird- Starling	46.3	4	9	19	2
Hawks (<i>Buteo</i>)	30.3	5	25	8	1
Swallows	23.4	7	2	21	≥32
Meadowlark	1.6	12	nl	nl	13
Heron	1.3	14	22	12	0
Mourning Dove	0.9	16	17	13	11
Sparrow	0.4	18	4	20	4
American Kestrel	0.2	20	14	16	28 (1)
Crow	0.2	20	12	18	1
Shorebirds	0.1	21	12	17	3
Killdeer	0.2	20	^d	^d	20 (2)
Horned Lark	24.9	6	^e	^e	14-32 (3)
Rock Dove	1.4	13	24	10	5 (11)

^a From Zakrajsek and Bissonette 2005

^b From Dolbeer et al. 2000

^c Birds struck at Westover ARB, MA

^d No species-specific Hazard Index calculated for Killdeer. Presumably is included in “Shorebirds.”

^e No species-specific Hazard Index calculated for Horned Lark

Table 6. Summary of opportunistic observations of BASH-risk bird species at Westover ARB, MA June-July 2004.

<u>Species</u>	<u>Hazard rank ^a</u>	<u>No. of observations</u>	<u>Total individuals observed</u>	<u>Mean individuals per observation</u>
Turkey Vulture	1	4	4	1
European Starling	4	4	430	108
Red-winged Blackbird	4	2	60	30
Red-tailed Hawk	5	15	17	1
“Swallows”	7	8	193	24
Great Blue Heron	14	5	6	1
Mourning Dove	16	11	666	61
American Crow	20	3	13	4
American Kestrel	20	12	24	2
Northern Harrier	^b	1	1	1

^a Zakrajsek and Bissonette 2005

^b unranked

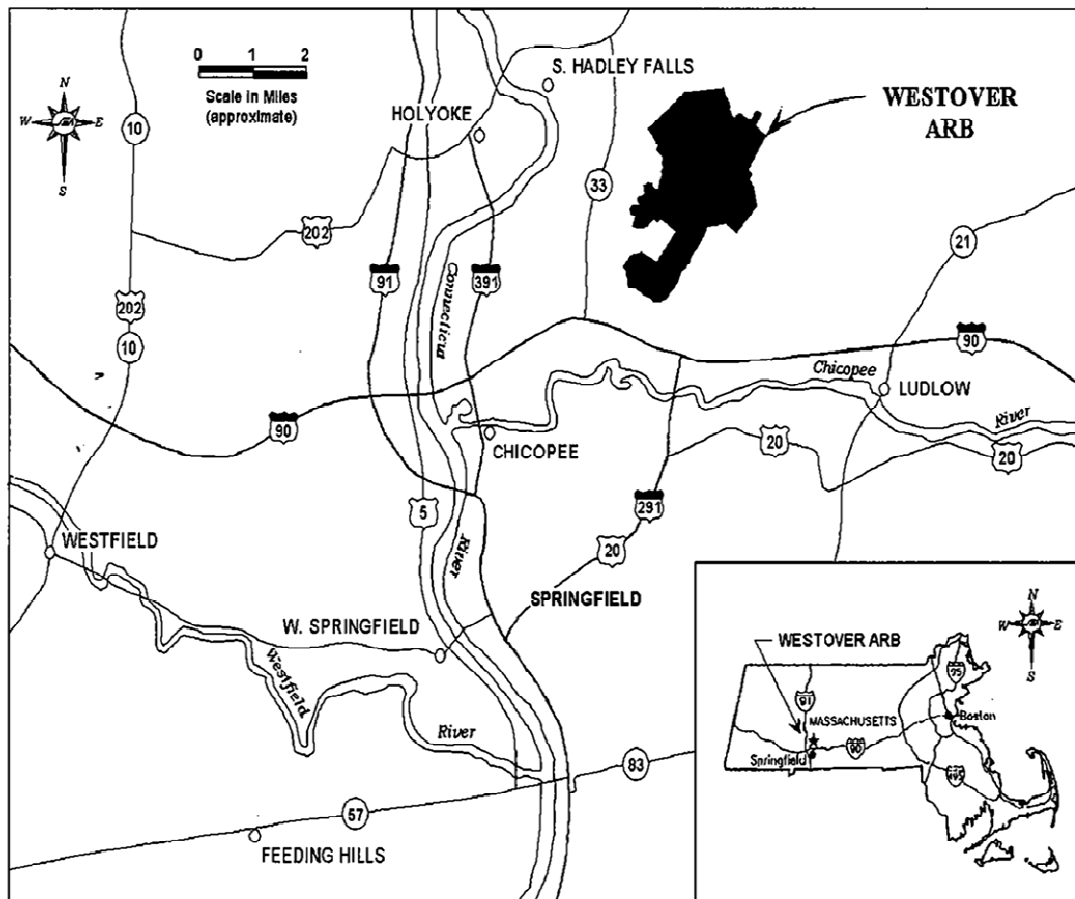


Figure 1. Study site location: Westover ARB, MA, USA.

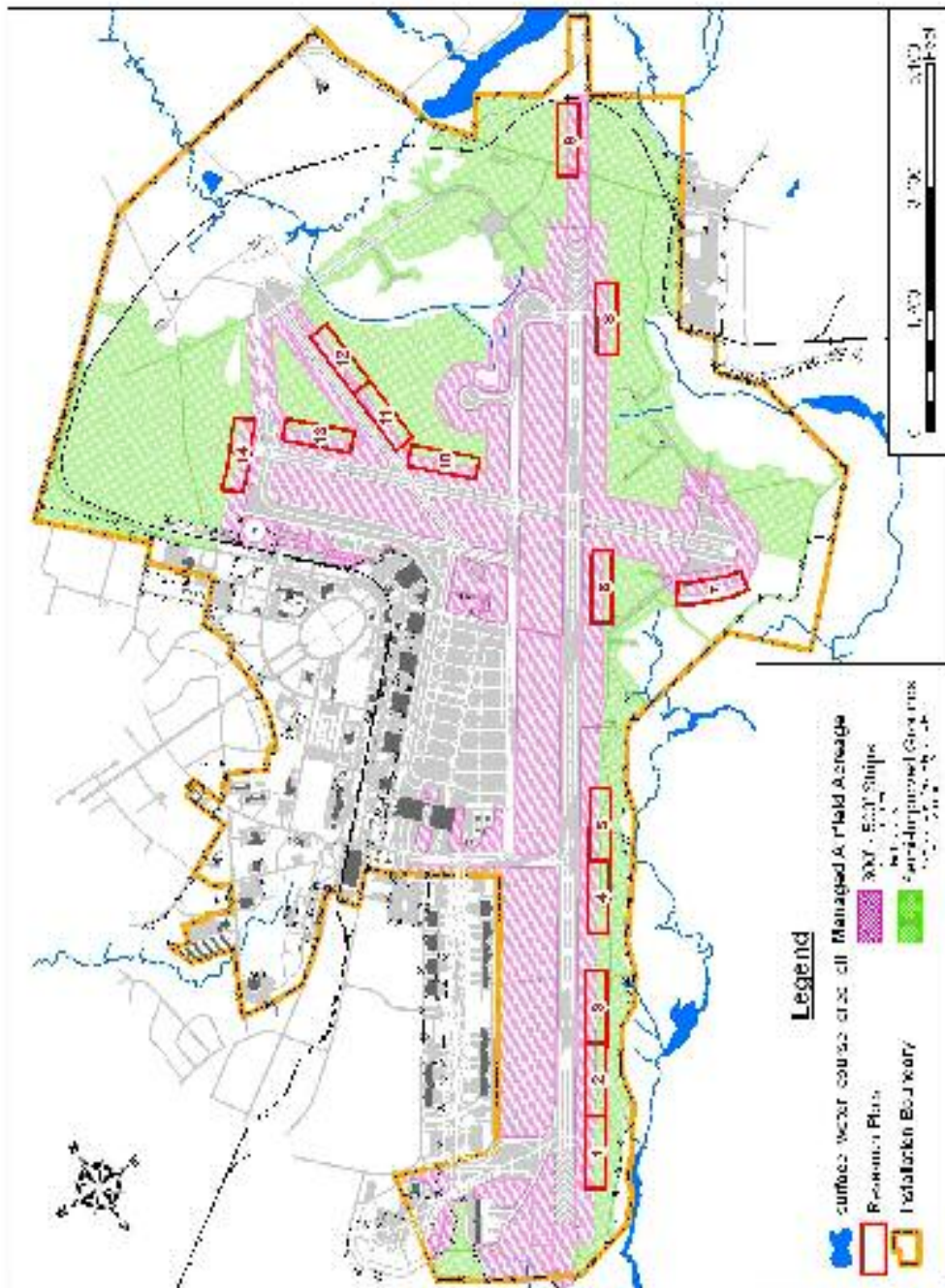


Figure 2. BASH Plan mowing map with research plots, Westover ARB, MA 2004.

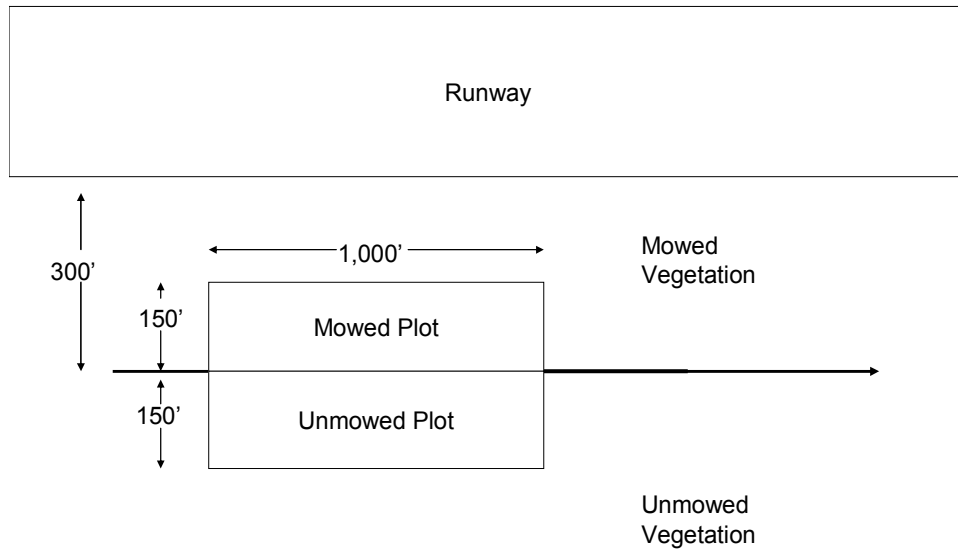


Figure 3. Configuration of matched pair of research plots, Westover ARB, MA 2004.

APPENDIX

ADDITIONAL MANAGEMENT AND RESEARCH RECOMMENDATIONS

The USDA National Wildlife Research Center in Sandusky, Ohio and AgResearch of Canterbury, New Zealand conduct research that seeks to reduce wildlife threats at airports. They are experimenting with cultivars of Tall Fescue (*Festuca arundinacea*) and other grasses that are infected with an endophytic fungus that makes the grass unpalatable to BASH species like Canada Geese, rodents and deer. This fungus may also interfere with the ability of small mammals to reproduce, discourage insects, and allow the grass to grow with less water and nutrients (Washburn and Seamans 2004, Pennel and Rolston 2004). The Federal Aviation Administration (FAA) has not yet recommended that endophyte-infected plants be used at airports but finds this to be a promising approach. FAA will not issue general guidelines on grass height or vegetation type for airport ground cover until more research is completed (Cleary and Dolbeer 2005).

At what height should the vegetation be maintained? In the United Kingdom, where 15-25 cm is the norm, Deacon and Rochard (2000) suggest a minimum height of 20 cm and an upper limit of 25 cm (consistent with airfield operational requirements and the ability of the grass to stay upright) as a starting point. However, they also suggest that a cutting regime that better discourages BASH-risk birds may be discovered through more up-to-date research.

Conversely, very tall grass can attract and conceal large birds that hunt insects and small vertebrates, and flocks of smaller birds that feed on grass or weed seeds. Maintaining 20 cm grass height might reduce the food supply and cover of many large

and flocking species and make them easier to detect. Any change would have to be tested to determine whether the new habitat created would attract species had previously avoided the airport (Deacon and Rochard 2000).

Researchers at Stuttgart Airport found that biodiverse meadows and tall oat-grass meadows in the airport area are typically not attractive to species that are a risk to flight safety. Managers there have reduced mowing frequency (frequency unstated) except around signposts, lights, taxiways and instrument landing system antennas because mowed areas do attract more birds of all kinds, including BASH species (Schmid and Matthaus 2005).

Based upon overall body mass and the increased likelihood of being struck, the presence of a bird flock is a larger BASH risk than is the presence of one or a few individuals of that species (Searing et al. 1996). The mowed portion of paired plot 14, located adjacent to the northwest end of Runway 15/33, should be monitored closely for BASH potential from flocking birds, primarily Mourning Doves. Flocks of birds (42, 66, 29 and 45 individuals, mostly Mourning Doves) were present in the mowed portion of paired plot 14 in sampling rounds 3-6. The corresponding bird numbers in the paired unmowed plot were 10, 22, 7 and 19. Conversion of this area to a monoculture of native Little Bluestem grass would reduce its production of weed seeds and might reduce its attractiveness to flocking birds. The conversion would be consistent with the Westover ARB BASH, Vegetation Management and Integrated Natural Resources Management plans.

I did not observe any Canada Geese in upland vegetation on the airfield during my study, and therefore did not observe any relationship between airfield mowing and

presence or absence of geese. Waterfowl are significant threats to aviation safety because of their large body mass and flocking behaviors. At other times, however, geese have infrequently been present on lawns near the Westover Metropolitan Airport, which is contiguous with the Base airfield, and in both mowed and unmowed airfield vegetation. Resident flocks of Canada Geese, transient geese and ducks and pairs of Mute Swans (*Cygnus olor*) are present in wetlands and small ponds both at Westover and ≤ 2 km from the airfield. In March 2000, a Westover C-5A transport aircraft sustained nearly \$15,000 in damage to a landing gear door when it collided with a Mallard (*Anas platyrhynchos*) (439 AW/SE 2006). Five species of ducks are listed nationwide in the Air Force's top 50 species of involved in bird strikes by cost, and 2 species are in the top 50 by strike frequency (260). Nationwide, Canada Geese were third by cost to the Air Force (over \$85 million) although 44th by count (72) (Air Force Safety 2005).

Managing the waterfowl threat at Westover is presently a combination of population management off-base and vegetation management on-base. USDA Wildlife Services biologists work with 2 local golf courses to reduce nesting resident goose populations via egg oiling and depredation (shooting) (M. Cozine, USDA/Wildlife Services, personal communication). Grounds workers mow airfield vegetation per Air Force directives, as discussed. I do not plant vegetation for erosion control or other purposes that geese or other waterfowl find palatable. Upon the advice of a consultant, the Air Force has left trees between the adjacent Ludlow Conservation Area marsh and the airfield in an effort to screen the airfield from view of geese in the marsh. Geese and ducks are occasionally present in the Stony Brook wetland on the north side of

Westover, outside the flight paths of aircraft. Geese and swans are most often present in impoundments in the Ludlow Conservation Area north of the airfield and in Chicopee Memorial State Park to the south. These impoundments are directly under aircraft flight paths or within 300 m of them. Base managers should investigate having those landowners lower the water level of these impoundments to discourage use by resident and migrant Canada Geese and swans. Removing or largely breaching the dams at these impoundments would reduce a significant BASH threat, and likely increase fish passage in a watershed with many dams. However, lowering the artificially high water levels would have impacts on aquatic organisms and wetlands that would have to be evaluated and authorized by permitting agencies in advance.

Efforts by landfill operators and USDA/APHIS/Wildlife Services personnel to manage the landfills and disperse gulls have decreased the threat at Westover since the early 1990's. The gulls had been attracted to nearby landfills in great numbers. Gulls caused damaging strikes to the engine of a fully loaded C-5A cargo aircraft on takeoff from Westover in January 1991. The crew was able to control the aircraft and land safely. Gulls have caused over \$9 million worth of damage to Air Force aircraft with 6 species among the top 50 struck (Air Force Safety 2005).

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