Vegetation preferences of captive Canada geese at Elmendorf Air Force Base, Alaska

Patricia A. Pochop, John L. Cummings, Kate L. Wedemeyer, Richard M. Engeman, and James E. Davis, Jr.

Abstract Bird–aircraft strikes represent a serious safety and economic problem in the United States. Canada geese (*Branta canadensis*) are frequently attracted to airfields because of the availability of preferred forage and large open areas. At Elmendorf Air Force Base, Alaska, we determined preferences of captive, wild-caught, lesser Canada geese (*B. c. parvipes*) for alternative vegetation types not normally planted at this airfield. We compared Canada goose preferences for Kentucky bluegrass (*Poa pratensis*), bluejoint reedgrass (*Calamagrostis canadensis*), beach wildrye (*Elymus mollis*), Bering hairgrass (*Deschampsia beringensis*), lupine (*Lupinus nootkatensis*), and flightline turf (a mix of smooth brome [*Bromus* sp.], dock [*Rumex acerosella*], and red fescue [*Festuca rubra*]). Geese preferred flightline turf over Kentucky bluegrass. Bering hairgrass was marginally less preferred than Kentucky bluegrass. Kentucky bluegrass was preferred over lupine, bluejoint reedgrass, and beach wildrye. We discuss vegetation management as an alternative goose control technique. Further evaluation of the least preferred vegetation types should be conducted in large flight pen and field plot studies.

Key words airport, bird hazard, *Branta canadensis,* Canada geese, cover management, forage

Bird–aircraft strikes are a serious economic and safety problem in the United States, causing over $200 million annually in damage to civilian and military aircraft and the occasional loss of human life (Dolbeer et al. 1995). The United States Air Force reported 13,379 bird–wildlife strikes to aircraft worldwide between 1989 and 1993 (United States Air Force Bird Air Strike Hazard Team, unpublished data). These strikes resulted in 8 lost aircraft, 1 pilot fatality, and 1 permanently disabled pilot. The damage estimates during this period exceeded $85 million. The most significant military aircraft disaster caused by birds occurred at Elmendorf Air Force Base (EAFB), near Anchorage, Alaska, on 22 September 1995, when an E-3 Sentry Airborne Warning and Control System (AWACS) aircraft struck several Canada geese (*Branta canadensis*) on takeoff and crashed, killing 24 people (Bird 1996).

At EAFB, several species of birds, specifically lesser Canada geese (*B. c. parvipes*), other waterfowl, ravens (*Corvus corax*), and gulls (*Larus* spp.), have been observed on the airfield. Canada geese are attracted to the airfield because of the availability of preferred forage for feeding and large open areas for loafing. Canada goose populations are likely to continue to grow in the Anchorage area (Crowley et al., unpublished report, Alaska Department of Fish and Game, Anchorage, Alaska, 1997), thus increasing the risk of other serious accidents involving aircraft and birds.

Reducing bird hazards at airports is an important management consideration. Methods to reduce and control bird activity at airfields have included

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using frightening devices such as propane exploders, pyrotechnics, flagging, and chemical frightening agents; repellents; trapping; and selective removal of pest birds (Godin 1994). These methods are considered short-term solutions because of cost, logistics, and effectiveness. Long-term methods include soil cement and asphalt. Soil cement (a chemical applied to the soil that makes it harden like cement) will fracture in the cold temperatures of Alaska and create a foreign objects and debris (FOD) problem. Asphalt is too expensive (approximately $90,000/ha versus bluejoint reedgrass at about $200/ha). Vegetation is economical and also prevents FOD and dust from becoming airborne. Therefore, vegetation management is being examined as a long-term and more cost-effective method to deter bird use at EAFB.

Currently, the most common approach to reducing airfield use by birds is habitat management involving maintaining vegetation height at 17 to 35 cm. Long grass restricts the line of sight of birds, making them vulnerable and nervous about unseen approaching predators (Brough and Bridgman 1980, Conover and Kania 1991). However, in Hawaii, long-grass management was not effective, because it attracted many granivorous birds and it caused territorial lesser Pacific golden-plovers to move onto runways and taxiways where they increased the hazard of bird-aircraft strikes (M. A. Linnell et al., unpublished report, Utah State University, Logan, Utah, 1996). Mowing and fertilizing grass, as practiced at some airports, encourages new growth, which attracts geese (Owen 1975). At EAFB, long-grass management (mowed once/year, >30 cm height) was being used in the infield areas at the time of the 1995 AWACS crash.

An alternative to long-grass management for bird control is to establish a less preferred vegetation type. Important characteristics for an ideal vegetation for airfields include minimal seed production, drought resistance, unattractiveness to invertebrates, poor rodent harborage, ability to exclude other plants, relatively non-flammable, resistance to vehicular traffic, ability to grow to a desired height, and minimal maintenance (Austin-Smith and Lewis 1970; M. A. Linnell et al., unpublished report, Utah State University, Logan, Utah, 1996). Vegetative species that are not already established in an area should be evaluated carefully, because of the potential for an exotic species to become a pest (Austin-Smith and Lewis 1970). Criticisms of a least-preferred-vegetation approach are that this technique is unproven, may be more expensive than long grass as a bird deterrent, and published information on the subject is limited (Austin-Smith and Lewis 1970; Brough and Bridgman; Linnell et al., unpublished report, Utah State University, Logan, Utah, 1996). Our objective was to determine lesser Canada goose preferences among some candidate vegetative species that are not normally planted on airfields.

Methods

We selected vegetation types for evaluation based on their availability, stiffness of growth, height, and adaptability to local conditions. We selected bluejoint reedgrass (*Calamagrostis canadensis*), a native of Alaska from the bluejoint grass family, which already grows in stands on EAFB; beach wildrye (*Elymus mollis*), an Alaska native that propagates mostly by rhizomes (Klebesadel 1985); Bering hairgrass (*Deschampsia beringensis*), a cultured grass adapted to Alaska and commercially available; lupine (*Lupinus nootkatensis*), a wild Alaskan flower and nitrogen fixer that successfully invades disturbed areas and outcompetes other plants; and flightline turf (a mix of smooth brome [*Bromus* sp.], dock [*Rumex acerosella*], and red fescue [*Festuca rubra*]), found along the runways at EAFB (Swanson and Miller, unpublished data, United States Department of Agriculture, Natural Resources Conservation Service, Alaska State Office, Anchorage; Figure 1).

We captured 50 adult Canada geese of undetermined sex during July 1996 in Anchorage, Alaska, and transported them to EAFB. At EAFB, we placed the geese in covered holding pens (10×10×2 m) and provided mixed grains, Purina bird chow, and water *ad libitum* during a 10-day quarantine-acclimation period. Afterwards, we housed each goose individually in a 3×2×2-m pen with a dirt floor void of vegetation.

We collected samples of each species, along with the soil immediately surrounding the roots, and placed them in a 30×23×16.5-cm plastic pan within 3 days of testing. The vegetation density was similar within each treatment type. We pulled dandelions (*Taraxacum* spp.), paper birch (*Betula papyrifera*), balsam poplar (*Populus balsamifera*), boreal yarrow (*Achillea borealis*), and Kentucky bluegrass (*Poa pratensis*) so that a pure stand of each test plant was offered to each goose. We clipped grasses to 30 cm within 4 hours of offering it to the geese because vegetation is mowed to that height on EAFB. Lupine, which is a legume, was not clipped. We purchased Kentucky bluegrass from a sod farm, placed it in plastic pans as described above, and used it within 3 days of purchase.

We compared preferences of 35 Canada geese for each plant species in a 2-choice test with Kentucky bluegrass as the control. We randomly assigned 7 geese to each treatment for 5 days, then randomly reassigned these geese to another treatment for 5 days, etc., until each goose sampled each of the 5 treatments during the 25-day test. We evenly distributed treatments throughout the test to reduce any time bias. We presented each goose with one pan of test vegetation and one pan of Kentucky bluegrass (control). We placed both pans of vegetation within each pen at ground level, approximately 1 m apart in the front 2 corners of the pen, and replaced pans daily. We alternated the positions of the treatment and control pans daily.

Table 1. Proportion of time Canada geese spent feeding on each of 5 vegetation types compared to a Kentucky bluegrass control in a 2-choice trial at Elmendorf Air Force Base, Alaska, 26 July through 19 August 1996.

Vegetation	Treatment	2-choice $\bar{x}$	Proportion of active feeding time for each treatment $\bar{x}$
Flightline turf	Control	0.063	
	Treatment	0.094	0.562
Bering hairgrass	Control	0.068	
	Treatment	0.052	0.413
Lupine	Control	0.102	
	Treatment	0.040	0.199
Bluejoint reedgrass	Control	0.092	
	Treatment	0.035	0.271
Beach wildrye	Control	0.093	
	Treatment	0.019	0.138

Two observers watched 5 geese each in 4 separate groups during the 4-hour test (Figure 2). We conducted tests between 0700 and 1200 hours and observed geese from a vehicle located at least 5 m from the closest pen. The initial group of 10 geese were offered their respective treatment and control pans of vegetation. We immediately initiated observations and continued them for 1 hour. We repeated this for the second group of 10 geese, the third group of 10 geese, and the fourth group of 5 geese. The activity each goose was engaged in during the observation was marked; C - foraging on control turf, T - foraging on treatment, O - engaged in some other activity such as loafing, preening, etc. We defined foraging as a goose with its head down moving its bill among the vegetation or manipulating a bunch of vegetation in its mouth. We observed geese at 15-second intervals in the same order within an observation period. We observed groups of geese in the same order throughout the test. Geese had free access to mixed grains and Purina bird chow after the observation period was completed (1200 to 1800

Figure 1. Cutting the Kentucky bluegrass into 30×23-cm pieces and placing it into a plastic pan. Left top, bluejoint reedgrass; left bottom, Bering hairgrass. Right top, beach wildrye; right middle, lupine; right bottom, flightline turf.

Figure 2. Observer in a vehicle collecting data on a goose foraging on the Kentucky bluegrass control, Elmendorf Air Force Base, Alaska.

hours). No food was provided overnight (1800 to 0700 hour). Water was available *ad libitum*.

We determined percentage of observations (time) spent foraging by dividing number of observations for control and treatment vegetation by total number of observations possible in each 1-hour period. We analyzed the foraging data using the SAS PROC MIXED (SAS Institute Inc., Cary, N.C.) procedure for mixed linear models. Because geese spent time in activities other than feeding, we conducted a separate analysis to compare treatments, given that the geese were actively feeding. We did this by determining the percentage of feeding time that geese fed only on each treatment. We also analyzed this data set using the SAS PROC MIXED procedure. We analyzed all possible pair-wise linear contrasts among treatments and applied the Bonferroni inequality (Miller 1985) for conservatively making inferences among treatment differences at an experiment-wise error rate of 0.05 (i.e., 10 possible pair-wise contrasts imply that an experiment-wise error rate is achieved if 0.05/10=0.005 is considered the level at which a contrast is significant).

Results

Canada geese showed a significant treatment-by-choice interaction ($F_{4,136}$=25.36, P<0.001) where treatment refers to the 5 vegetation types and choice refers to foraging on a treatment vegetation or the alternate choice of the Kentucky bluegrass control (Table 1). Flightline turf was preferred over Kentucky bluegrass. Bering hairgrass was marginally less preferred than Kentucky bluegrass. Kentucky bluegrass was preferred over lupine, bluejoint reedgrass, and beach wildrye. Similarly, there were differences in proportion of time geese spent feeding among treatments, given that they were engaged in feeding activity ($F_{4,136}$=49.43, P<0.001). Geese preferred the flightline turf over the 4 other vegetation types ($F_{1,136}$>18, P<0.001, in each case). Beach wildrye was the plant species that received the least feeding pressure in this study, although statistically we could not detect a difference between beach wildrye and lupine ($F_{1,136}$=3.18, P=0.077), but we found a difference between beach wildrye and bluejoint reedgrass ($F_{1,136}$=14.95, P<0.001).

Discussion

Beach wildrye has tough, heavily cutinized leaves and stems, which protect it from the abrasive effects of blowing sand (Klebesadel 1985) and give it a greater tensile strength over plants that are less heavily cutinized. Some studies have indicated that tensile strength may be a proximate cue that geese use to select or avoid forage (Owen et al. 1977, Conover 1991). However, Buchsbaum and Valiela (1987) found that phenolic compounds had a greater role than fiber in deterring feeding on unpalatable plants. High-fiber (and therefore presumably less digestible) grasses were generally favored over the low-fiber succulent forbs, because the succulents (such as marsh-rosemary

Sign placed near the runway after the 1995 AWACS crash on Elmendorf Air Force Base, Alaska.

[*Limonium carolinianum*] and goldenrod [*Solidago sempervirens*]) were protected by secondary metabolites (Buchsbaum et al. 1984).

Lupine and bluejoint reedgrass showed some potential for deterring Canada goose foraging in a mature state. Where lupine was somewhat woody and dry in a mature state, bluejoint reedgrass appeared to have fewer dried leaves than a species such as Bering hairgrass. However, we are concerned about how well these species, when in an immature state, would deter Canada goose foraging when these plants would be more succulent and potentially more attractive to geese. This would be very important in spring, or when whole stretches of areas near runways would need to be replanted. Possibly at this stage and until the plants reach a mature state (less preferred), other management techniques (i.e., hazing, fencing, etc.) would have to be implemented. In contrast, Bering hairgrass was only marginally less preferred than Kentucky bluegrass and we do not recommend it to deter Canada geese from foraging near airport runways.

An interesting and unexpected result was that flightline turf was preferred over Kentucky bluegrass. Conover (1991) found that tall fescue (*Festuca arundinaceae*) was significantly disliked by Canada geese compared to red fescue, colonial bentgrass (*Agrostis tenuis*), and perennial ryegrass (*Lolium perenne*). The flightline turf at EAFB contains red fescue. It is possible that this is the component that geese were selecting for, but we did not conduct and were not able to find any research concerning palatability of smooth brome or dock to Canada geese, and they cannot be ruled out as a preferred food source. In addition, the flightline turf was fertilized in the spring, which would contribute to its attractiveness to geese (Owen 1975).

The plant species in this study were tested in summer, when they were in a mature state. Testing beach wildrye, lupine, and bluejoint reedgrass in spring when shoots are young and tender would help determine whether any of these forages would be palatable to geese in the early stages of growth. Further, a plant species that is not attractive to geese throughout all stages of growth would offer a more viable long-term solution than a plant species that geese avoid only during a particular stage of growth.

Other non-grass forage also should be considered to deter airfield use by geese. For example, Conover (1991) found that even hungry Canada geese refused to eat common periwinkle (*Vinca minor*), Japanese pachysandra (*Pachysandra terminalis*), and English ivy (*Hedera helix*). Smith (1976) found that mouse-eared hawkweed (*Hieracium pilosella*) reduced invertebrate and bird (primarily herring gulls [*Larus argentatus*]) activity over a mixed-species cover (wild carrot [*Daucus carota*], daisy [*Chrysanthemum* sp.], dandelion [*Taraxicum* sp.], plantain [*Plantago* sp.], snapdragon [*Antirrhinum* sp.], and clover [*Trifolium* sp.]). Buchsbaum and Valiela (1987) found that geese avoided forbs during all seasons. Non-grass species (i.e., forbs that contain phenolic compounds) that are native to Alaska, such as sweet holygrass (*Hierochloe odorata*) which contains coumarin, should be tested as alternative vegetative covers at EAFB.

Management implications

Habitat management could be a viable method to deter Canada goose use of EAFB. The 3 vegetation types (beach wildrye, bluejoint reedgrass, and lupine) that were most effective in our study each require different planting schemes and maintenance. Beach wildrye seed is not available commercially, but a local source of supply in the Anchorage area is currently under development. Advantages of beach wildrye include reproducing through rhizomes (good ground stabilization attribute), resistance to chemical de-icers, resistance to lodging by wind and rain, and out-competing other plants. One disadvantage of beach wildrye is its sensitivity to compaction, implying that vehicles could not be driven regularly on it.

Bluejoint reedgrass is commercially available on a limited basis and would cost $104/ha. Wild bluejoint grass is native to Alaska and grows most commonly in meadows and wet areas. However, bluejoint reedgrass has a very small seed, which is difficult to cultivate. Because bluejoint reedgrass already grows in stands on EAFB, another option might be to transplant it to areas adjacent to EAFB runways.

Lupine would be the most difficult of the 3 plant species to plant and maintain. Seeds would need to be gathered from wild stands. If problems arise in cultivating the seeds, transplanting entire plants may be difficult because of the extensive taproot. However, lupine is resistant to lodging and, though susceptible to mowing, usually grows to about 30–60 cm high.

Further studies using bluejoint reedgrass, lupine, beach wildrye, and possibly other plant species are warranted. Large flight pen and field plot studies could offer the opportunity to determine the least preferred of the 3 plant species by Canada geese and the limitations of propagating these plant species on a large scale. Vegetation management may offer a long-term solution and decreased costs compared to other bird management techniques.

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Effect of xanthan gum and traditional mosquito larvicides on chironomid larvae

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Abstract Chironomid larvae are an important food source for many species of wildlife that depend upon wetland habitats. Using various pesticides to control mosquitoes may impact chironomid larvae, with important consequences to the quality of these wetland habitats for wildlife. We tested the effect of traditional mosquito larvicides: *Bacillus thuringiensis* var. *israelensis* (BTI), temephos, a carbohydrate gum thickener (xanthan gum), and a modified starch (National 5370) on chironomid larvae in a wetland located in eastern Delaware. Only temephos reduced numbers of live chironomid larvae observed ($P<0.01$). We discuss the potential role of a carbohydrate-based mosquito control method in wetlands where chironomid larvae are the nontarget invertebrates of concern.

Key words Abate®, aquatic invertebrates, *Bacillius thuringiensis,* chironomids, mosquito control, temephos, wetlands, xanthan gum

Aquatic invertebrates are critically important to many species of wetland-associated wildlife (Drobney and Fredrickson 1979, Connelly and Chesmore 1980, Miller 1987, Euliss et al. 1991, Helmers 1991, Skagan and Oman 1996). Chironomids frequently comprise the largest proportion of wetland invertebrate biomass (Reid 1982, Eldridge 1992, Szekely and Bamberger 1992, Rehfisch 1994, Davis and Smith 1998). Chironomids are selected by shorebirds feeding in freshwater wetlands (Baldassarre and Fischer 1984, Helmers 1991, Eldridge 1992, Davis and Smith 1998), by waterfowl (Swanson and Meyer 1977, Connelly and Chesmore 1980, Sugden and Driver 1980, Euliss and Harris 1987, Euliss et al. 1991, Gammonley 1995), and by numerous species of fish (Pinder 1986, Ali 1991*a*).

Wetland managers manipulate habitats to provide wildlife food resources and to make these foods available at the appropriate time. Wildlife use of a wetland habitat is often associated with density of invertebrates (Krebs and Cowie 1976, Hicklin and Smith 1984, Helmers 1991, Botton et al. 1994, Weber and Haig 1996, Davis and Smith 1998). Quantity of food also can influence wildlife migration chronology (Dunn et al. 1988), condition (Evans 1976), and subsequent life history events (Richardson and Kaminski 1992). Management activities to increase certain types of wildlife foods also may increase incidence of mosquito breeding. When this occurs, local mosquito control agencies often approach land managers to allow mosquito control efforts to be conducted within these wetlands. Using certain mosquito control pesticides may negate efforts to provide quality wildlife habitat by drastically reducing quantities of invertebrate foods.

Mosquito control is important to the public from the aspect of nuisance, health, and economy. Though many currently used mosquito control lar-

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