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Evaluation of Trash-Transfer Facilities as Bird Attractants

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NOTICE

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16. Abstract

Wildlife collisions (wildlife strikes) with aircraft pose a serious risk to aircraft and cost civil aviation in the United States an estimated $490 million annually. Traditional putrescible-waste landfills are very attractive to and are used by many birds, especially gulls, creating a hazard to aircraft if located near airports. The Federal Aviation Administration currently recommends that the location of municipal solid waste landfills and trash-transfer facilities should not be within 5 statute miles of an airport. Little information is available regarding the attractiveness of trash-transfer facilities to wildlife and the potential risk to aviation, particularly on a national scale. The objectives of this study were to (1) document wildlife use of trash-transfer facilities and (2) determine if the building design or the on-site management characteristics of trash-transfer facilities influence their attractiveness to wildlife species. Twenty-nine trash-transfer facilities and four control sites, located in seven states (representative of various U.S. geographical regions) were studied. Wildlife (primarily birds) abundance and activity were quantified at each facility and control site twice per week for 1 year. Patterns of wildlife use at these facilities differed by building design, season, geographic location, and on-site management characteristics. Bird species that are hazardous to aviation commonly observed using trash-transfer facilities (e.g., feeding) included European starlings, gulls, rock pigeons, and crows.

Overall, the findings from this study demonstrate that wildlife use of trash-transfer facilities, particularly by bird species that are hazardous to aviation, can be significant and potentially increase the risk of bird strikes within airport environments. Consequently, trash-transfer facilities in close proximity to airport environments should be evaluated on an individual basis to determine whether or not they are attractive to or influence the movement patterns of wildlife and if the location of such a facility increases the risk to safe aircraft operations. Appropriate wildlife control activities could be conducted at trash-transfer facilities to reduce the wildlife attraction and thus decrease the risk of bird strikes associated with those facilities.

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LIST OF ACRONYMS

AGL	Above ground level
FAA	Federal Aviation Administration
NWRC	National Wildlife Research Center
SAS	Statistical Analysis System

EXECUTIVE SUMMARY

Wildlife collisions (wildlife strikes) with aircraft pose a serious risk to aircraft and cost civil aviation in the United States an estimated $490 million annually. Traditional putrescible-waste landfills are very attractive to, and are used by, many birds (especially gulls) for feeding, creating a hazard to aircraft if located near airports. The Federal Aviation Administration currently recommends that the location of municipal solid waste landfills and trash-transfer facilities should not be within 5 statute miles of an airport. Little information is available regarding the attraction of trash-transfer facilities to wildlife and the potential risk to aviation, particularly on a national scale. The objectives of this study were to (1) document wildlife use of trash-transfer facilities and (2) determine if the building design or the on-site management characteristics of the trash-transfer facilities influenced the attractiveness to wildlife species. Twenty-nine trash-transfer facilities and four control sites, located in seven states (representative of various U.S. geographical regions), were studied. Wildlife (primarily birds) abundance and activity were quantified at each facility and control site twice per week for 1 year.

The movement patterns of wildlife use at these facilities differed by geographic location, building design, and on-site management characteristics. Bird species hazardous to aviation commonly observed using trash-transfer facilities for feeding included gulls, European starlings, rock pigeons, and crows.

Overall, the findings from this study demonstrate that wildlife use of trash-transfer facilities, particularly by bird species hazardous to aviation, can be significant. Thus, trash-transfer facilities represent potential wildlife attractants that should be evaluated during wildlife hazard assessments and other evaluations within airport environments. In addition, this study suggests that several factors, including building design, season, geographic location, and on-site management practices can influence wildlife use of trash-transfer facilities. Consequently, trash-transfer facilities in close proximity to airport environments should be evaluated on an individual basis to determine whether or not they attract wildlife and if the location of such a facility increases the risk to safe aircraft operations.

1. INTRODUCTION.

Collisions between aircraft and wildlife generally have been termed bird or wildlife strikes. Wildlife strikes to the civil aviation industry in the United States are both costly (estimated annual costs range from $101 to $503 million) and deadly (nine fatalities since 1990 [1]). Worldwide, wildlife strikes have caused more than 147 human fatalities and destroyed approximately 120 aircraft since 1990 [2 and 3]. Overall, it is estimated that the worldwide cost of wildlife strikes to the aviation industry is about $1.2 billion per year [4]. Most wildlife strikes occur near airports, with approximately 74% of all bird strikes occurring below 150 m above ground level (AGL) and 92% at or below 900 m AGL [1]. Gulls (Larus spp.); waterfowl, such as Canada geese (Branta canadensis); hawks (Falconiformes); and owls (Strigiformes); and blackbirds (Icteridae)/starlings (Sturnus vulgaris), in particular, are of great concern at airports [1, 5, and 6]. Habitat management techniques that reduce birds on and around airports are therefore critical for safe airport operations.

Traditional putrescible-waste landfills are very attractive to and are used by many birds, especially gulls, creating a hazard to aircraft if located near airports [7 and 8]. The Federal Aviation Administration (FAA) currently recommends that the location of municipal solid waste landfills and trash-transfer facilities should not be within 5 statute miles of an airport [9 and 10]. There has been an increase in the number of trash-transfer facilities, a trend that will likely continue into the future. Consequently, there is a concern that these facilities attract bird species hazardous to aviation. If trash-transfer facilities serve as attractants for gulls and other birds, as do landfills, the presence of these facilities near airports could increase the risk to aircraft operations [7, 11, 12, and 8]. Little information is available regarding how attractive trash-transfer facilities are to birds. Previous studies [4 and 13] compared two waste management facilities in one county in both Ohio and New Jersey, respectively, and found that birds used trash-transfer facilities less than landfills. Unfortunately, both studies involved only two facilities in each county.

Whether the design of an open-sided, fully enclosed trash-transfer facility is attractive to hazardous bird species, particularly at the national scale, is currently unknown. The objective of this study was to examine various designs of trash-transfer facilities located in different geographic regions of the country (northeast, midwest, southwest, and northwest) by comparing more than 20 facilities. This provided important information to the FAA concerning how attractive trash-transfer facilities are to bird species.

The specific objectives of this study were to (1) determine if trash-transfer facilities attract wildlife species (primarily birds) and (2) determine if the design characteristics of trash-transfer facilities influence the attractiveness to bird species. The null hypothesis is that bird use was not different among trash-transfer facilities of various designs. The information provided by this study will be useful in determining if and what type of trash-transfer facilities are compatible with safe aircraft operations. The National Wildlife Research Center (NWRC) Institutional Animal Care and Use Committee approved the procedures before beginning the study.

2. METHODS.

Trash-transfer facilities of various designs were inventoried in seven states (Arizona, Ohio, Massachusetts, Connecticut, Washington, California, and Missouri), representing different geographic regions of the United States. From these inventories, 29 trash-transfer facilities and four grocery stores were selected as control sites (table 1). Although there were considerable variations in building design, the trash-transfer facilities were categorized as either completely open, three-sided open, three-sided bays, semi-enclosed, or fully enclosed. Completely open trash-transfer facilities had no walls or were surrounded by a chain-link fence (figure 1). A three-sided open trash-transfer facility had three walls and a fourth side was completely open (figure 2). Three-sided bay facilities had three walls and a fourth side that had a series of bay doors that were left open (figure 3). Semi-enclosed facilities had four walls or chain-link-fenced sides with large openings on two sides of the building (figure 4). Fully enclosed trash-transfer facilities had four walls with doors large enough for trash trucks to enter or exit the facility (figure 5). Control sites (i.e., a grocery store) consisted of a building similar in size and shape to trash-transfer facility buildings, but refuse was typically not present.

Table 1. Trash-Transfer Facilties Summarized by Building Type and State

Building Type	States	Number
Control	Arizona, Connecticut, Ohio, Washington	4
Completely open	Massachusetts, Ohio, Washington	3
Three-sided open	Arizona, Washington	5
Three-sided bays	Arizona, Massachusetts, Missouri, Ohio, Washington	9
Semi-enclosed	Arizona, California, Washington	6
Fully enclosed	Arizona, Connecticut, Massachusetts, Washington	6
Total		33

Figure 1. Completely Open Trash-Transfer Facility

Figure 2. Three-Sided, Open Trash-Transfer Facility

Figure 3. Three-Sided, Trash-Transfer Facility With Bay Doors

Figure 4. Semi-Enclosed Trash-Transfer Facility

Figure 5. Fully Enclosed Trash-Transfer Facility

At each facility, Wildlife Services biologists and specialists, under the supervision of an NWRC research biologist, conducted 30 minutes of observation (point-counts) that consisted of two 15-minute counts at two predetermined observation locations. The two observation locations were selected to provide a complete view of the facility. Wildlife observations were conducted on two randomly chosen days per week (Monday through Friday) for 1 year at each control site and trash-transfer facility. In total, each facility was surveyed between 44 and 111 days (mean of 94 days) during this period, resulting in an average of 47 hours of observation per facility and a total of 1553 hours for the complete study. These surveys were randomly stratified so that the surveys were conducted evenly during morning (06:00-11:00), midday (11:00-16:00), and evening (16:00-21:00) periods each month at each facility. During each 15-minute survey, the presence, number, and behavior of all birds observed within 0.25 mile of the facility or control site were recorded. The behavior of birds using the site was recorded by species and categorized as (1) pass flying over the site and exhibiting no perceived interest in the site (e.g., soaring turkey vultures riding thermal currents); (2) locally flying over or around the site and exhibiting a perceived interest in the site (e.g., circular flight pattern with head movement suggesting the search for food); (3) loafing on the ground; (4) feeding on the ground; (5) loafing on a refuse transport vehicle; (6) feeding on a refuse transport vehicle; (7) loafing on or in the trash-transfer facility; and (8) feeding on or in the trash-transfer facility. If the birds exhibited different behaviors during the 15-minute period, each activity was recorded. Birds that left the area (i.e., flew out of the sight of the observer) and returned during the same 15-minute period were considered new birds.

During each 15-minute survey, wildlife biologists also counted the number of commercial (i.e., curbside refuse collection trucks) and private (e.g., pickup trucks and trailers) trucks that were present or arrived at the facility. Any instances when refuse "fell off or out of" trash trucks were also recorded. In addition, at the start of each survey, the observer assessed the amount of uncontained refuse that was outside the building (e.g., on the ground) and available to wildlife and recorded this information in four site-rating categories: "none," "slight," "moderate," or "heavy." The percentage of times the amount of uncontained refuse was categorized into each site-rating level was calculated for each facility.

Site-specific management information, including the average tons of refuse per day processed at the facility, the size of the building or work area, whether or not rodent control was used on-site, and whether or not odor control was used, was obtained from the onsite manager for each trash-transfer facility. In addition, the linear distance (in km) from the facility to the nearest major body of water (e.g., ocean, lake, or major river) was determined for each trash-transfer facility and control site.

For the purpose of data analyses and because these observations were not independent, the two 15-minute surveys conducted at each facility each day were summed to provide a single 30-minute survey. To limit consideration only to birds that were actually using the trash-transfer facilities, birds with the "pass flying," "locally flying," "loafing on the ground," and "feeding on the ground" activity codes were removed from the data prior to subsequent statistical analyses. The bird observation data were not normally distributed and could not be transformed satisfactorily. Therefore, bird use among trash-transfer facilities and control sites by all birds, gulls, and European starlings was compared using the Kruskal-Wallis tests [14]. Correlation analyses were used to determine if relationships existed between trash-transfer characteristics (e.g., building size, distance to major water body) and the mean number of all birds, gulls, and European starlings using trash-transfer facilities [14]. Differences were considered statistically significant according to a value of $P \leq 0.05$, where P is defined as the probability that the correlation observed in the data would have been observed by chance if in fact the correlation did not exist. All analyses were conducted using statistical analysis system (SAS) software version 9.1 (SAS Institute, Cary, NC). Data are presented as mean ±1 standard error.

3. RESULTS.

3.1 WILDLIFE OBSERVATIONS.

At the 29 trash-transfer facilities studied during the 1-year period, 771,586 birds, representing 108 species, were observed during 2,716 thirty-minute surveys, or on average, 284.1 birds per survey. At the four grocery stores (i.e., control sites) studied during the same time period, 37,115 birds, representing 40 species, were observed during 390 thirty-minute surveys, or on average, 95.2 birds per survey.

European starlings, gulls, rock pigeons, and crows were the bird species/groups most frequently observed near and using the trash-transfer facilities and control sites during this study (table 2).

Starlings and gulls accounted for 78.1% of all birds observed during the study and 78.8% of the birds observed actually using the trash-transfer facilities and control sites.

Table 2. Total Number of Birds Observed and Number of Birds Using Trash-Transfer Facilities by Species

Species/Group	Total Number Observed[a]	Percent of All Birds Observed[b]	Total Number Observed Using[c]	Percent of All Birds Using[d]
European starlings	448,044	55.4	195,340	50.2
Gulls	183,558	22.7	111,138	28.6
Rock pigeons	56,674	7.0	33,161	8.5
Corvids	40,641	5.0	22,839	5.9
House sparrows	33,911	4.2	12,998	3.3
Blackbirds	25,661	3.2	8,768	2.3
Egrets and Herons	5,989	0.7	3,756	1.0
Doves	5,116	0.6	392	0.1
Vultures	956	0.1	125	<0.1
Raptors	538	0.1	25	<0.1
Other species	7,570	0.9	370	0.1
Total	808,702		388,920	

[a] Total number of birds observed (includes all activities) at all facilities
[b] Percent of all birds observed (includes all activities) of each species/group
[c] Total number of birds observed using trash-transfer facilities and control buildings (includes only activities associated with trash-transfer buildings, trucks, and refuse piles)
[d] Percent of all birds observed using trash-transfer facilities and control buildings (includes only activities associated with trash-transfer buildings, trucks, and refuse piles) of each species/group

One fully enclosed trash-transfer facility had an average of 1344.6 birds using the facility per 30-minute survey, more than 4 times higher than the mean number of birds using any of the other fully enclosed facilities (figure 6). The mean number of birds using fully enclosed trash-transfer stations was 322.5 ±41.6 birds per survey. The average number of gulls and European starlings using fully enclosed trash-transfer stations were 51.4 ±7.0 per survey and 250.4 ±40.0 per survey, respectively. Because this facility likely had an overriding influence and biased the data, the bird observation data from this facility were removed for the "building type" analyses, and when the bird use data were reanalyzed, the mean number of birds using fully enclosed trash-transfer stations was 85.2 ±8.3 birds per survey. The average number of gulls and European starlings using fully enclosed trash-transfer stations were then 61.1 ±4.3 per survey and 20.3 ±4.3 per survey, respectively.

The mean number of birds using trash-transfer facilities of various building designs (ranging from 58.0 to 120.0 total birds observed per 30-minute survey) was 2.6 to 5.4 times higher than the average number of total birds observed using control sites (0 = 22.1 birds per survey; table 3). This frequency distribution suggests statistical significance with values of $\chi^2 = 286.8$ (where

χ^2 is a statistical calculation used to test how well the distribution of a set of observed data matches a theoretical probability distribution. The calculated value is equal to the sum of the squares of the differences divided by the expected values) and P <0.0001. Gulls were observed using trash-transfer facilities (ranging from 26.9 to 69.7 total gulls observed per 30-minute survey) more (χ^2 = 194.4, P <0.0001) than control sites (0 = 1.2 gulls per survey; see table 3). Starlings exhibited a similar pattern; starlings were observed using trash-transfer stations of different building designs (ranging from 9.5 to 46.3 total starlings observed per 30-minute survey) more (χ^2 = 485.2, P <0.0001) than control sites (0 = 0.6 starlings per survey; table 3).

Table 3. Mean Number of Birds Using Trash-Transfer Facilties and Control Sites

Building Type	All Birds[a] Mean ±SE	Gulls[b, c] Mean ±SE	European Starlings Mean ±SE
Control	22.1 ±3.2 A[d]	1.2 ±0.2 A	0.6 ±0.1 A
Completely open	89.0 ±6.7 C	26.9 ±3.5 B	46.3 ±5.3 D
Three-sided, open	58.0 ±4.5 B	37.7 ±4.6 C	9.5 ±1.7 B
Three-sided, bays	85.1 ±5.1 C	60.2 ±5.7 D	26.1 ±2.4 C
Semi-enclosed	120.0 ±13.1 C	69.7 ±11.4 D	12.7 ±1.1 B
Fully enclosed[e]	85.2 ±8.3 C	61.1 ±9.4 D	20.3 ±4.3 C

[a] Consists of the total number of birds of all species.
[b] Consists of the total number of gulls from 8 species.
[c] For analyses of gulls, trash-transfer stations in Arizona and Missouri were excluded as gulls were not observed at facilities in these states.
[d] Means within the same column with the same letter are not different (P >0.05) according to a Kruskal-Wallis test.
[e] One fully enclosed trash-transfer facility was excluded from these analyses due to its overwhelming influence on the data.

SE = Standard error of the mean.

Bird use of trash-transfer facilities varied considerably among those buildings that were of the same design (figure 6). The greatest amount of variation in the number of birds using trash-transfer facilities occurred among the fully enclosed trash-transfer facilities. The largest average number of birds using trash-transfer facilities were at the aforementioned fully enclosed facility (1344.6 ±189.9 birds per survey) and a semi-enclosed trash-transfer facility (630.0 ±63.1 birds per survey). In contrast, four trash-transfer facilities (two of the three-sided bays design and two of the fully enclosed design) had a mean number of birds using the facility less than 3.0 per survey (figure 6).

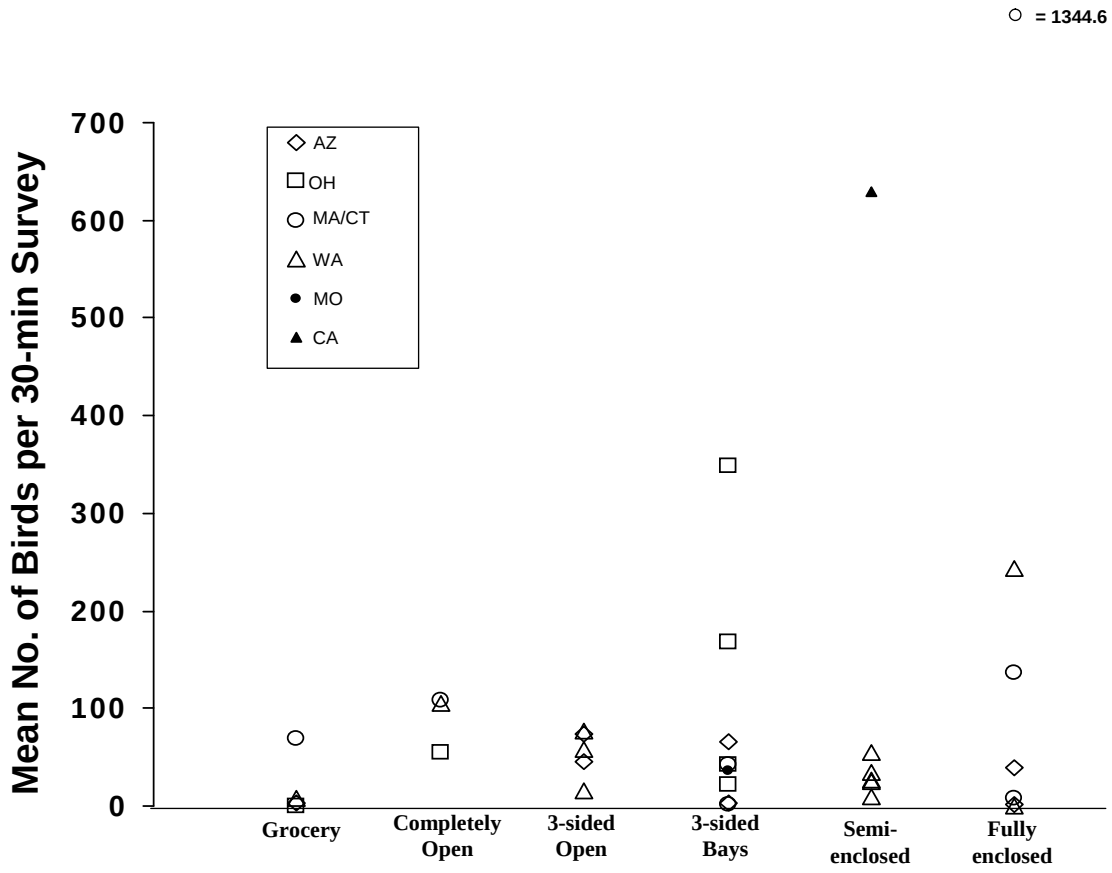

Figure 6. Mean Number of Birds (All Species) Observed Using Trash-Transfer Stations and Control Sites

The average number of birds (all species) observed using trash-transfer sites and control sites varied (χ^2 = 200.5, P <0.0001) seasonally (figure 7). Similarly, use of trash-transfer facilities and control sites by gulls (χ^2 = 211.8, P <0.0001) (figure 8) and European starlings (χ^2 = 142.3, P <0.0001) (figure 9) followed a similar trend. In general, bird use of trash-transfer facilities was highest during the winter months (December to February) and lowest during the summer months (May to August).

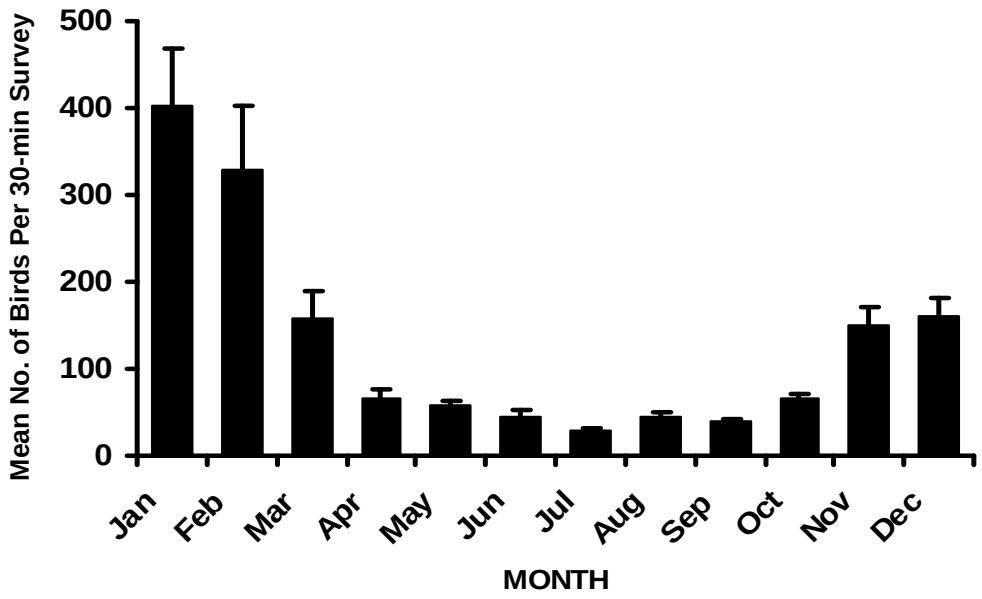

Figure 7. Mean Number of Birds (All Species) Observed Each Month Using Trash-Transfer Stations and Control Sites

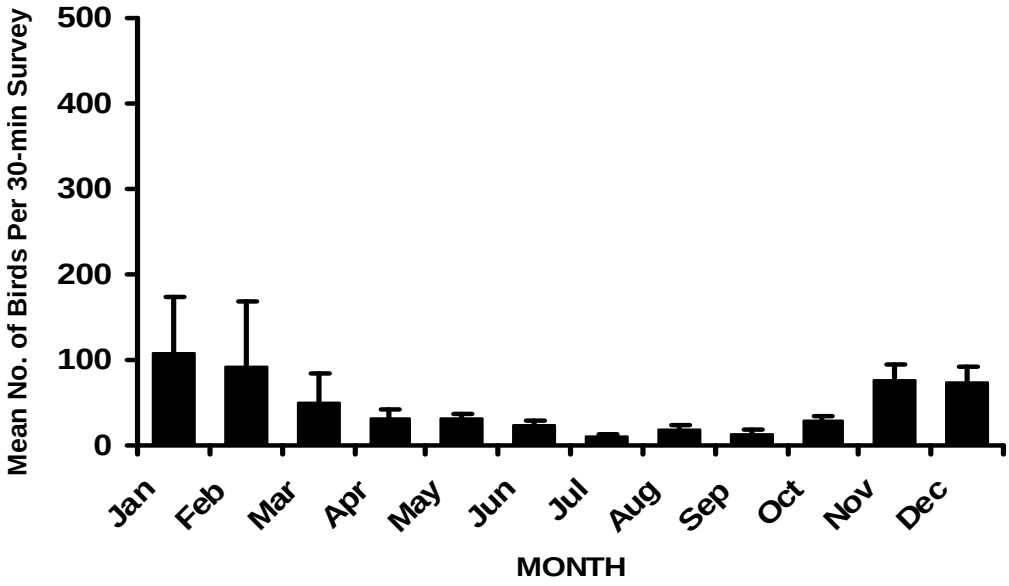

Figure 8. Mean Number of Gulls (Eight Species) Observed Each Month Using Trash-Transfer Stations and Control Sites

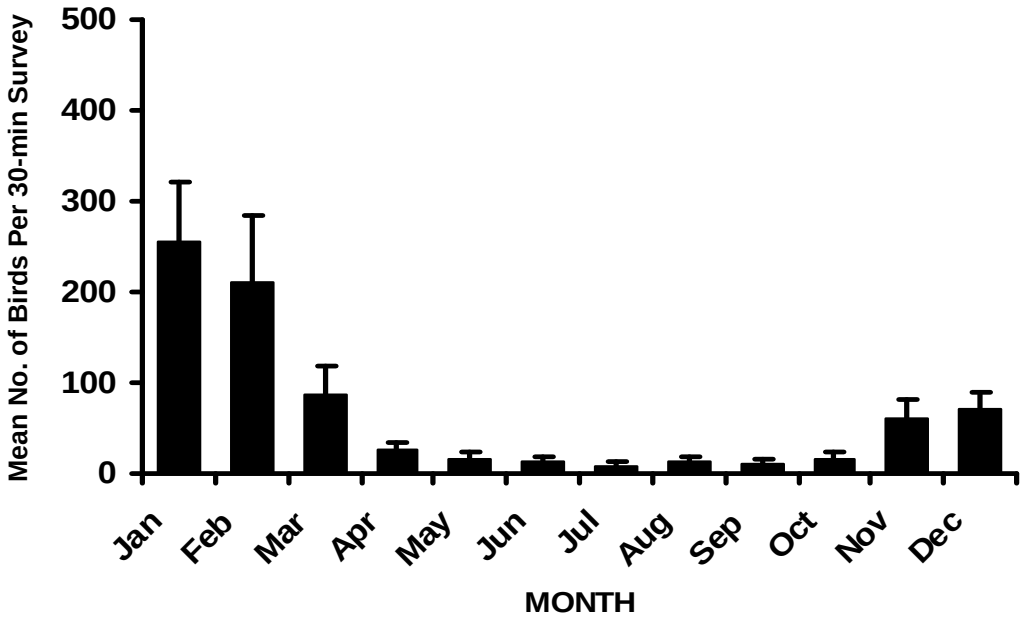

Figure 9. Mean Number of European Starlings Observed Each Month Using Trash-Transfer Stations and Control Sites

The geographic location of the trash-transfer facilities influenced the amount of bird use that was observed during the study. On average, more (χ^2 = 333.0, P <0.0001) birds per 30-minute survey were observed using trash-transfer facilities and control sites in California (630.0 ±2.6 birds per survey), Massachusetts and Connecticut (321.2 ±42.8 birds per survey), and Ohio (106.0 ±6.9 birds per survey) than in Arizona (33.0 ±2.7 birds per survey) and Missouri (36.8 ±9.0 birds per survey); bird use of Washington trash-transfer stations (58.4 ±3.6 birds per survey) was intermediate to other states. The average number of gulls at the California trash-transfer facility (462.7 ±60.7 gulls per survey) was greater (χ^2 = 222.9, P <0.0001) than gull use of trash-transfer facilities and control sites in Massachusetts and Connecticut (11.5 ±1.2 gulls per survey), Ohio (60.5 ±5.5 gulls per survey), and Washington (26.6 ±2.8 gulls per survey). No gulls were observed using trash-transfer stations in Arizona or Missouri.

Similarly, starling use of trash-transfer facilities and control sites differed (χ2 = 620.7, P <0.0001) among states. On average, the highest average number of starlings per survey using trash-transfer facilities was in Massachusetts and Connecticut (277.5 ±40.9 starlings per survey), whereas trash-transfer stations and control sites in Arizona (2.9 ±0.9 starlings per survey) and Washington (9.8 ±0.7 starlings per survey) had the lowest.

Birds accounted for over 99% of all wildlife observed near and using the trash-transfer facilities and control sites during this study. A total of 46 mammals, representing 9 species, were observed near or using the trash-transfer facilities or control sites (table 4). Of these 46 mammals, only 8 (17%) were actually observed using the trash-transfer facilities (e.g., foraging on or in the refuse).

Table 4. Total Number of Mammals Observed Near and Using the Trash-Transfer Facilities and Control Sites

Mammals	Total Number Observed	Total Number Using
Coyote (Canis latrans)	2	0
Desert cottontail rabbit (Sylvilagus auduboni)	2	0
Feral cat (Felis sylvestris)	12	1
Feral dog (Canis lupus familiaris)	13	6
Eastern fox squirrel (Sciurus niger)	4	1
Raccoon (Procyon lotor)	3	0
Rat (Rattus sp.)	2	0
White-tailed deer (Odocoileus virginianus)	7	0
Woodchuck (Marmota monax)	1	0
Total	46	8

3.2 TRASH-TRANSFER FACILITY CHARACTERISTICS.

At the 29 trash-transfer facilities studied during a 1-year period, a total of 27,113 trash trucks were counted. Those trucks included both commercial trash trucks (i.e., curbside refuse collection trucks) and private vehicles (e.g., pickup trucks and small trailers). There was an average of 10.0 trash trucks (commercial and private) per 30-minute survey. Overall, commercial trash trucks accounted for 58.2% of the trucks, whereas private vehicles accounted for 41.8%. The proportion of commercial versus private trash trucks differed among facilities; trash-transfer facilities in Arizona, Missouri, and Ohio had a high proportion of commercial trash trucks (82%-94%), whereas the proportion of private trucks was equal to commercial trucks in Massachusetts and Connecticut. At trash-transfer facilities in Washington, private vehicles accounted for 67.9% of the total trash trucks. Refuse was observed "falling off" from commercial or private trucks only 0.4% of the observations (a total of 129 occasions).

The average number of total birds using trash-transfer facilities was positively correlated with the building size using Pearson's correlation coefficient ($r = 0.445$, $P = 0.02$), tons of trash per day ($r = 0.602$, $P < 0.001$), and the percent of site ratings categorized as "moderate" amount of uncontained refuse on the ground ($r = 0.419$, $P = 0.02$). Similarly, the average number of gulls using trash-transfer facilities was positively correlated with building size ($r = 0.547$, $P = 0.01$) and the percent of site ratings categorized as "heavy" amounts of refuse on the ground ($r = 0.681$, $P < 0.001$). Trash-transfer facility use by European starlings was positively correlated with tons of trash per day ($r = 0.543$, $P = 0.002$) and the percent of site ratings categorized as "moderate" amounts of refuse on the ground ($r = 0.381$, $P = 0.04$). Distance to a major water body and the percent of site ratings categorized as "none" and "slight" amounts of refuse on the ground were not correlated ($P > 0.05$) with bird use of trash-transfer facilities.

The average number of total birds using trash-transfer facilities with an active rodent control program (n = 22; 128.9 ±60.7 birds per survey) was not different (χ^2 = 0.84, P = 0.36) than the average number of total birds using trash-transfer facilities without an active rodent control program (n = 7; 139.3 ±82.7 birds per survey). Similarly, the average numbers of total birds using trash-transfer facilities with (n = 8; 214.5 ±163.1 birds per survey) and without (n = 21; 99.8 ±31.8 birds per survey) an odor control program were similar (χ^2 = 0.50, P = 0.48).

4. DISCUSSION.

Trash-transfer stations are facilities where municipal solid waste is unloaded from small trucks (e.g., curbside refuse collection trucks) and reloaded into large vehicles (e.g., container trucks) for transport to a final disposal site, such as a landfill [15]. Trash-transfer facilities have the potential to attract wildlife, in particular species of birds that are hazardous to safe aircraft operations. Previous studies of the wildlife use of trash-transfer facilities have been very restricted geographically (i.e., within a single county) and in sample size [13, 8, and 16].

The number of birds using trash-transfer stations differed among facilities of different building type, but not in a consistent pattern. It was originally hypothesized that the number of birds actually using trash-transfer facilities would decrease as the trash-transfer buildings became more enclosed. Trash-transfer facilities with more open walls would be expected to have more bird use as the refuse would potentially be more exposed and available to the birds. However, the data from this study do not support that hypothesis.

The amount of bird use among the trash-transfer facilities varied considerably in this study. Bird use of trash-transfer stations was most variable among facilities of the "three-sided, bays," "semi-enclosed," and "fully enclosed" designs. There were several facilities of these designs that had little to no bird use, whereas other facilities of similar design were apparently very attractive to and thus heavily used by hazardous birds. Consequently, the findings from this study suggest that no one specific building design was associated with limited wildlife use.

Gulls, consisting of eight individual species, accounted for almost one-third of the birds observed using trash-transfer facilities; whereas very few gulls were observed at control sites (i.e., grocery stores). Ring-billed gulls (Larus delawarensis), herring gulls (Larus argentatus), California gulls (Larus californicus), and western gulls (Larus occidentalis) were the most abundant gulls at trash-transfer facilities. The specific gull species present at trash-transfer facilities was dependent on the geographic location of those facilities and the geographic distribution of the gull species themselves. In addition to loafing on trash-transfer station buildings and trash trucks, gulls were often observed actively foraging upon refuse piles within the trash-transfer buildings and amongst moving heavy equipment and trucks. About half of all the birds observed using trash-transfer facilities were European starlings. Starlings and rock pigeons not only loafed on or in trash-transfer buildings and trucks, foraged on refuse piles within trash-transfer buildings or on litter outside of the buildings, but they also nested within the buildings. Crows were frequently observed using trash-transfer facilities, often loafing or feeding on parked trash trucks at the facilities. All these species represent significant hazards to safe aircraft operations [1 and 5] and their use of trash-transfer facilities for loafing and foraging could increase the risk of bird strikes, particularly if these birds traverse critical airspace

frequently used by aircraft and across runways as they travel to and from trash-transfer facilities. This is especially true for gulls. Studies of herring and ring-billed gulls suggest these birds can travel 22 kilometers or more from nesting colonies to landfills and do so several times each day [7 and 12].

Birds comprised almost all of the wildlife observed at or near trash-transfer facilities during this study; few mammals were observed, most of these were feral dogs that fed upon refuse. Although the potential for populations of commensal rodents to exist within and around trash-transfer facilities exists, most trash-transfer facilities used a commercial rodent control program (e.g., poison baits). Because rodents are nocturnal, these observations probably underestimated the numbers present.

Bird use of trash-transfer facilities varied considerably among seasons during this study. Bird use of trash-transfer facilities was greatest during the winter months and least during the summer months. This trend was evident for both gulls and European starlings. During the summer months, gulls are more likely to exploit food resources from aquatic sources (e.g., fish from freshwater lakes or marine environments). Belant, et al. [12], found that breeding herring gulls used natural food resources (e.g., fish) rather than foraging on refuse at landfills; however, anthropogenic food sources (e.g., garbage at landfills) were found to be important to post-breeding herring gulls. European starlings are likely to be using insect and vegetation (e.g., seeds) food resources during the summer months. In contrast, during the winter months, food resources for gulls and starlings are more limited and thus anthropogenic food resources might be more important and used with greater frequency. Because bird use of trash-transfer facilities was clearly influenced by season, assessments (e.g., surveys) of the risk to safe aircraft operations associated with trash-transfer facilities should be conducted so that all seasons are represented within the assessment period. Minimally, evaluation of trash-transfer stations for their attractiveness to wildlife hazardous to aviation should be conducted during the winter months.

The geographic location of a trash-transfer station appears to have a strong influence on the amount of bird use of that facility, particularly in reference to birds that are hazardous to aviation. Not unexpectedly, gull use of trash-transfer facilities was highest at trash-transfer facilities that were near coastal areas or the Great Lakes (e.g., California, Massachusetts, Ohio) but nonexistent at trash-transfer facilities in inland areas (e.g., Arizona, Missouri). Crows were most abundant and used trash-transfer facilities in the Pacific Northwest and northeast, but observed far less frequently at trash-transfer stations in other areas. The total numbers of birds, in addition to the species involved, that use a trash-transfer facility for loafing and foraging is likely a consequence of the abundance and diversity of bird species present in that geographic location.

The abundance of gulls, European starlings, and all birds using trash-transfer facilities was positively related to the proportion of site ratings categorized as having “moderate” or “heavy” amounts of refuse on the ground, suggesting that the amount of litter (i.e., uncontained trash) outside of the trash-transfer buildings themselves influences the use of these facilities by birds. Greater amounts of litter around the facility grounds might be more visible to birds that are flying near the facility and thus potentially could attract them to the sites. On-site management

practices that increase the "cleanliness" of trash-transfer stations, such as periodically removing litter and uncontained trash, therefore reduce the use of these facilities by hazardous birds.

5. SUMMARY.

Traditional putrescible-waste landfills are very attractive to and are used by many birds, especially gulls, creating a hazard to aircraft if located near airports [7 and 8]. The FAA currently recommends that the location of municipal solid waste landfills and trash-transfer facilities should not be within 5 statute miles of an airport [9 and 10]. There has been an increase in the number of trash-transfer facilities, a trend that will likely continue into the future. Consequently, there is a concern regarding the probability of these facilities to attract bird species hazardous to aviation. If trash-transfer facilities serve as attractants for gulls and other birds, as do landfills, the presence of these facilities near airports could increase the risk to aircraft operations [7, 11, 12, and 8].

The objectives of this study were to (1) document wildlife use of trash-transfer facilities and (2) determine if the building design or the on-site management characteristics of the trash-transfer facilities influenced the attractiveness to wildlife species. Twenty-nine trash-transfer facilities and four control sites, located in seven states (representative of various U.S. geographical regions), were studied. Wildlife (primarily birds) abundance and activity were quantified at each facility and control site twice per week for 1 year.

Overall, the findings from this study demonstrate that wildlife use of trash-transfer facilities, particularly by bird species considered to be hazardous to aviation, can be significant. Trash-transfer facilities represent potential wildlife attractants that should be evaluated during wildlife hazard assessments and other evaluations of wildlife hazards within airport environments. In addition, findings from this study suggest that several factors, including building design, season, geographic location, and on-site management practices can be important and influence the wildlife use of trash-transfer facilities. Consequently, trash-transfer facilities within airport environments should be evaluated on an individual basis to determine whether they attract or influence the movement patterns of hazardous wildlife and if the location of such a facility increases the risk to safe aircraft operations. Appropriate wildlife control activities could be conducted at trash-transfer facilities to reduce their attractiveness to hazardous wildlife and thus decrease the risk of bird strikes associated with those facilities.

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