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Talking trash in the Big Apple: mitigating bird strikes near the North Shore Marine Transfer Station

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Abstract: Anthropogenic activities that concentrate wildlife near airports increases the risk of wildlife–aircraft collisions. Placing waste management facilities, natural areas, golf courses, and other landscape features near airports have the potential to attract wildlife hazardous to aviation. We conducted a 3-year study (March 2013–February 2016) to determine if the implementation of a Wildlife Hazard Mitigation Program (WHMP) would influence the bird use of a waste transfer station located near LaGuardia Airport, New York City, New York, USA. We conducted wildlife surveys during 3 phases: (1) no mitigation program and no waste transfer station, (2) active mitigation and no waste transfer station, and (3) active mitigation and operating waste transfer station. Overall, bird abundance decreased when the WHMP was implemented, thereby reducing the risk of wildlife strikes with aircraft operating in association with LaGuardia Airport. The active mitigation program reduced the presence of birds associated with the waste transfer station as well as many species using the adjacent marine environment.

Key words: airports, bird strikes, New York, waste management, waste transfer station, wildlife–aircraft collisions, wildlife hazard mitigation

Wildlife collisions with aircraft (wildlife strikes) pose a serious hazard to aircraft and economic losses to aviation worldwide. Annual economic losses from such incidents with civil aircraft are conservatively estimated to exceed US$1.5 billion worldwide and US$1 billion in the United States alone (Allan et al. 2016, Dolbeer et al. 2019), but the actual cost (incorporating aircraft down time and other indirect costs) is likely much higher (Anderson et al. 2015).

Wildlife strikes also have resulted in the loss of >282 human lives and >263 military and civil aircraft since 1988 (Thorpe 2010, Dolbeer et al. 2019). Recent wildlife strike events, such as the ditching of US Airways Flight 1549 into the Hudson River, USA, have drawn the attention of local and national media and increased public interest in risks to aviation safety posed by wildlife.

Identifying and addressing land uses near airports that might attract hazardous wildlife, such as waste transfer stations and landfills (Figure 1), is an important component of an integrated approach to reduce wildlife–aircraft collisions (DeVault et al. 2013). The Federal Aviation Administration (FAA) discourages the development of waste disposal facilities (e.g., landfills, transfer stations) within 8 km of an airport (see FAA Advisory Circulars 150/5200-33B and 150/5200-34) because they often attract large numbers of scavenging birds (Patton 1988, Belant et al. 1993, Gabrey 1997, Washburn 2012), which can present a substantial risk to aviation safety.

North Shore Marine Transfer Station

In 2006, the city of New York, New York, USA issued a Comprehensive Solid Waste Management Plan for the long-term exportation and disposal of municipal solid waste from metropolitan New York City (Washburn et al. 2010). Included in this plan was a proposal to build a marine waste transfer station at a previously closed facility operated by the New York City Department of Sanitation (DSNY). The location of the proposed North Shore Marine Transfer Station (NSMTS) was in the College Point Section of Queens, New York. This facility was designed to be a fully enclosed

Figure 1. Flock of gulls scavenging at a waste transfer station (*photo courtesy of USDA Wildlife Services*).

Table 1. Description of the activities occurring during the 3 phases of a study conducted at the North Shore Marine Transfer Station, College Point, New York, USA, March 2013–February 2016.

	Phase I	Phase II	Phase III
Time period	March 2013–February 2014	March 2014–February 2015	March 2015–February 2016
Avian surveys conducted?	Yes	Yes	Yes
Putrescible waste being processed at the facility?	No	No	Yes
Active wildlife mitigation efforts occurring?	No	Yes	Yes

waste transfer station (i.e., 4 walled sides and small doors just large enough to allow refuse-collection vehicles to enter and exit; Washburn 2012). Construction of the facility was met with opposition from several stakeholders, as approval of the plan occurred just months after the ditching of US Airways Flight 1549 into the Hudson River event (Marra et al. 2009). Consequently, public awareness of the wildlife–aircraft collision issue was at an all-time high.

At the request of former U.S. Secretary of Transportation Ray LaHood, a technical panel of wildlife hazard mitigation experts from numerous state and federal agencies conducted an evaluation of the situation during 2009–2010. The panel concluded that by implementing a Wildlife Hazard Mitigation Program (WHMP) at a fully enclosed transfer station with strict

Figure 2. Map showing the location of the LaGuardia Airport and the North Shore Marine Transfer Station, College Point, New York, USA.

Figure 3. Cage trap used to live-capture rock pigeons (*Columba livia*; *photo courtesy of USDA Wildlife Services*).

operational procedures, DSNY could operate the NSMTS facility with low risk to aircraft operations associated with LaGuardia Airport (LGA; Washburn et al. 2010). The DSNY agreed to implement all of the technical panel's recommendations during the construction and operation of the NSMTS facility.

In March 2013, the U.S. Department of Agriculture, Animal and Plant Health Inspection Service, Wildlife Services (WS) began implementing aspects of the WHMP by monitoring avian abundance at the NSMTS site (Table 1). The NSMTS facility was completely constructed and became operational (i.e., putrescible waste was processed at the facility) in March 2015. The objective of our study was to quantify and compare the bird use of a waste transfer station during 3 phases: (1) no wildlife management actions at a non-operating waste transfer facility, (2) an active WHMP at a non-operating waste transfer facility, and (3) fully operational waste transfer with an active WHMP.

Study area

The NSMTS facility is located at the western terminus of 31st Avenue, directly on Flushing Bay in an industrial neighborhood within Flushing, New York. This site is 672 m from the landing threshold of Runway 13/31 at LGA (Figure 2). Approximately 1,000 aircraft movements occur at LGA each day. Wildlife species commonly present on or near LGA that pose a hazard to aviation include Canada geese (*Branta canadensis*), great black-backed gulls (*Larus marinus*), herring gulls (*L. argentatus*), ring-billed gulls (*L. delawarensis*), rock pigeons (*Columba livia*), and European starlings (*Sturnus vulgaris*).

Methods

Wildlife mitigation efforts

Putrescible waste was not visible to birds due to the fully enclosed design of NSMTS. All trash was processed and contained inside the facility. The pier, ramp, and other entry or exit points were inspected and cleaned multiple times per day by street sweeper and ground personnel.

Passive wildlife mitigation efforts were employed at the NSMTS during and after facility construction. Signs were posted throughout the property declaring a strict "no feeding wildlife" policy. Temporary standing water was removed if ponding occurred, and restrictions were put on landscaping features. Anti-perching devices were installed onto numerous structures, including concrete abutments, ramp supports, walls, light posts, electric poles, and on the perimeter of the NSMTS building roof.

Active wildlife mitigation actions (as specified in the WHMP) conducted at the NSMTS included dispersing birds from the property using pyrotechnics. Nonlethal dispersals were conducted after birds were recorded in a survey, during routine site monitoring, and opportunistically throughout the day. Cage traps were employed to lethally remove house sparrows (*Passer domesticus*) and rock pigeons (Figure 3). Firearms were used to lethally remove gulls and Canada geese and to reinforce nonlethal dispersals of other species. Nest and egg removals for rock pigeons, house sparrows, and barn swallows (*Hirundo rustica*) were conducted when they nested in or on the NSMTS building or other structures on the property.

Table 2. Wildlife mitigation activities conducted during Phases II and III of the study at the North Shore Marine Transfer Station, College Point, New York, USA, March 2013–February 2016.

Species/Guild	Phase II		Phase III	
	Dispersed	Removed	Dispersed	Removed
Ring-billed gulls (*Larus delawarensis*)	295	10	489	12
Herring gulls (*Larus argentatus*)	153	4	160	2
House sparrows (*Passer domesticus*)	132	1	193	20
European starlings (*Sturnus vulgaris*)	103	0	163	0
Rock pigeons (*Columba livia*)	105	7	135	8
Laughing gulls (*Leucophaeus atricilla*)	7	1	118	0
Canada geese (*Branta canadensis*)	56	41	52	5
Mallards (*Anas platyrhynchos*)	34	3	39	0
Other ducks[a]	93	4	85	0
Waterbirds[b]	6	3	29	0
All species combined	1,010	74	1,499	47

[a]Other ducks included American black ducks (*Anas rubripes*), bufflehead (*Bucephala albeola*), canvasbacks (*Aythya valisineria*), gadwall (*Anas strepera*), greater scaup (*Aythya marila*), lesser scaup (*Aythya affinis*), red-breasted mergansers (*Mergus serrator*), and ruddy ducks (*Oxyura jamaicensis*).

[b]Waterbirds included American coot (*Fulica americana*), belted kingfishers (*Megaceryle alcyon*), double-crested cormorants (*Phalacrocorax auritus*), red-necked grebes (*Podiceps grisegena*), and mute swans (*Cygnus olor*).

Avian surveys

We conducted avian point-count surveys for 3 years over 3 study phases at the NSMTS (Table 1). During Phase I (March 2013–February 2014), no wildlife mitigation actions occurred, the solid waste transfer station was not operational, and putrescible waste was not being processed on-site. During Phase II (March 2014–February 2015), wildlife mitigation actions were implemented; however, the waste transfer station was not operational (i.e., waste was not being processed on-site). During Phase III (March 2015–February 2016), wildlife mitigation actions were ongoing, the transfer station was fully operational, and putrescible waste was being processed on-site.

We conducted 3-minute point-count surveys each month (average of 10.5 surveys per month) at random start times (e.g., 2 surveys during sunrise to noon, 2 surveys during noon to sunset) at each of the 4 observation locations at the NSMTS (Hutto et al. 1986, Bibby et al. 2000). We identified all birds observed to the lowest possible taxonomic level and recorded the number and activity of all birds in or over the survey area. Bird activities included: feeding, loafing, roosting, nesting, "locally" flying, "pass" flying over the site, towering, standing, vocalizing, and preening. Although birds that only used the observational space as a movement corridor (i.e., "pass" flying over the site) were recorded, we did not use these data in our analyses (Buckland et al. 2001).

We used 2-way analysis of covariance (ANCOVA) and Fisher's Protected Least Significant Difference tests to compare the abundance of individual species, guilds, and all species combined among the study phases and months of the year (Neter et al. 1990, Zar 1996). We used the appropriate pre-treatment (i.e., Phase I) avian abundance as a covariate. Differences were considered significant at $P \leq 0.05$, and all analyses were conducted using SAS statistical software version 9.1 (SAS Institute, Cary, North Carolina, USA).

Wildlife hazard (severity)

Using the avian point-count data from NSMTS (i.e., pooled bird observations from each individual observation location) for all birds, we assigned each species to 1 of 6 hazard (severity) levels (i.e., "very low," "low," "moderate,"

Table 3. Mean (±SE) number of birds observed per 3-minute survey of selected individual species and guilds of birds during the 3 phases of the study at the North Shore Marine Transfer Station, College Point, New York, USA, March 2013– February 2016.

Species/Guild	Phase I	Phase II	Phase III
Ring-billed gulls (*Larus delawarensis*)	1.42 ± 0.24 a[a]	0.45 ± 0.27 b	0.99 ± 0.24 c
European starlings (*Sturnus vulgaris*)	1.08 ± 0.20 a	1.16 ± 0.23 a	1.12 ± 0.20 a
Rock pigeons (*Columba livia*)	0.88 ± 0.09 a	0.33 ± 0.11 b	0.29 ± 0.05 b
House sparrows (*Passer domesticus*)	0.86 ± 0.16 a	0.65 ± 0.18 a	0.98 ± 0.16 a
Herring gulls (*Larus argentatus*)	0.46 ± 0.05 a	0.34 ± 0.05 ab	0.32 ± 0.05 b
Laughing gulls (*Leucophaeus atricilla*)	0.04 ± 0.04 a	0.01 ± 0.04 a	0.16 ± 0.04 b
Great black-backed gulls (*Larus marinus*)	0.02 ± 0.01 a	0.02 ± 0.01 a	0.01 ± 0.01 a
Mallards (*Anas platyrhynchos*)	0.61 ± 0.10 a	0.09 ± 0.11 b	0.02 ± 0.10 b
Other ducks[b]	0.67 ± 0.09 a	0.17 ± 0.10 * b	0.11 ± 0.09 b
Waterbirds[c]	0.05 ± 0.01 a	0.04 ± 0.01 a	0.02 ± 0.01 b
Swallows[d]	0.13 ± 0.03 a	0.14 ± 0.04 a	0.20 ± 0.03 a
All species combined	6.78 ± 0.48 a	3.60 ± 0.55 b	4.40 ± 0.49 b

[a]Means within the same row with the same letter are not statistically different ($P > 0.05$).

[b]Other ducks included American black ducks (*Anas rubripes*), bufflehead (*Bucephala albeola*), canvasbacks (*Aythya valisineria*), gadwall (*Anas strepera*), greater scaup (*Aythya marila*), lesser scaup (*Aythya affinis*), red-breasted mergansers (*Mergus serrator*), and ruddy ducks (*Oxyura jamaicensis*).

[c]Waterbirds included American coot (*Fulica americana*), belted kingfishers (*Megaceryle alcyon*), double-crested cormorants (*Phalacrocorax auritus*), red-necked grebes (*Podiceps grisegena*), and mute swans (*Cygnus olor*).

[d]Swallows included barn swallows (*Hirundo rustica*), chimney swifts (*Chaetura pelagica*), cliff swallows (*Petrochelidon pyrrhonota*), northern rough-winged swallows (*Stelgidopteryx serripennis*), and tree swallows (*Tachycineta bicolor*).

"high," "very high," and "extremely high") as defined by Dolbeer and Wright (2009). Bird species not specifically listed in Dolbeer and Wright (2009) were assigned to the "very low" hazard level due to their small body size (<1 kg), tendency for non-flocking behavior, or other factors that suggest they pose minimal hazards to aircraft (DeVault et al. 2011). We compared the proportion of total birds within each hazard (severity) level among the 3 phases using *G*-tests for independence (Zar 1996).

Results

Wildlife mitigation efforts

Using pyrotechnics, WS dispersed 2,498 birds from the NSMTS from March 2014–February 2016. During Phase II of the study, 1,006 birds were dispersed, and during Phase III, 1,492 birds were dispersed. Ring-billed gulls, house sparrows, herring gulls, and European starlings comprised 31%, 13%, 13%, and 11% of the total birds dispersed, respectively (Table 2).

During Phases II and III, 121 birds were lethally removed via firearms and trapping. Canada geese, ring-billed gulls, house sparrows, and rock pigeons accounted for the most removals at 38%, 18%, 17%, and 12%, respectively. In addition, 15 house sparrow, 6 rock pigeon, and 2 barn swallow nests were removed during nesting seasons. Of the active wildlife mitigation actions undertaken, 7% and 5% of the activities conducted involved lethal removal of individual birds during Phases II and III, respectively.

Avian surveys

We conducted 378 3-minute avian point-count surveys during the entire study period of March 2013–February 2016. We conducted 131, 110, and 137 avian surveys during Phases I, II, and III, respectively. We observed 7,502 individual birds representing 52 species during avian surveys. European starlings, ring-bulled gulls, house sparrows, and rock pigeons

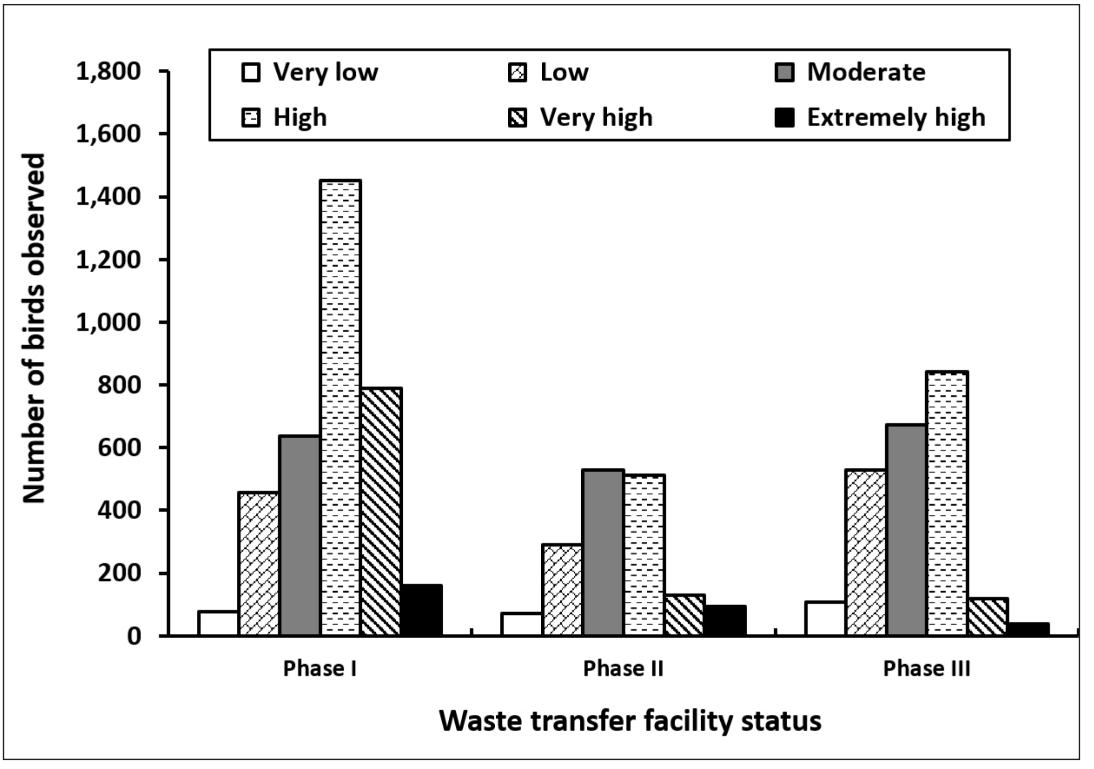

Figure 4. Graph showing the distribution of birds within 6 wildlife hazard (severity) categories for all birds observed during Phases I, II, and III at the North Shore Marine Transfer Station site, College Point, New York, USA, March 2013–February 2016.

were the most common species, accounting for 23%, 19%, 17%, and 10% of the total bird observations, respectively.

Mean numbers of birds observed per survey varied among the 3 study phases for rock pigeons ($F_{2,72}$ = 12.04, $P \leq 0.001$), herring gulls ($F_{2,72}$ = 3.07, P = 0.05), laughing gulls (*Leucophaeus atricilla*; $F_{2,72}$ = 4.12, P = 0.02), mallards (*Anas platyrhynchos*; $F_{2,72}$ = 11.02, $P <$ 0.0001), waterbirds ($F_{2,72}$ = 4.11, P = 0.02), and other ducks ($F_{2,72}$ = 12.06, $P \leq 0.001$). More birds were observed during Phase I of the study than during Phases II or III for all of these species except laughing gulls (Table 1). For laughing gulls, the average number of birds observed was higher during Phase III than during the other 2 phases (Table 3). We found a significant interaction between phase and month for ring-billed gulls ($F_{22,79}$ = 4.94, $P \leq 0.001$), Canada geese ($F_{22,72}$ = 1.83, P = 0.03), Atlantic brant (*B. bernicla*; $F_{22,79}$ = 2.07, P = 0.01), and all species combined ($F_{22,79}$ = 2.51, P = 0.002).

The mean number of house sparrows and swallows observed per survey were similar (both $P > 0.33$) among the 3 study phases (Table 3) but differed among months (both $P \leq 0.001$). In contrast to the other bird species, numbers of European starlings, great black-backed gulls, and shorebirds were similar (all $P > 0.30$) among the 3 study phases (Table 3) and among months (all $P > 0.61$).

Wildlife hazard (severity)

Overall, birds in the "very low," "low," and "moderate" hazard levels (as defined by Dolbeer and Wright 2009) remained fairly consistent during the 3 phases of the study (Figure 4). In contrast, birds in the 'high' hazard level were less abundant (G = 484.5, $P < 0.0001$), 65% and 42% fewer during Phases II and III, respectively, relative to Phase I. Compared to Phase I, there were 82% and 85% fewer (G = 790.8, $P < 0.0001$) birds in the "very high" hazard level during Phases II and III, respectively. For birds in the "extremely high" hazard level, we found declines (G = 80.0, P < 0.0001) of 40% and 76% during Phases II and III, respectively (Figure 2).

Discussion

We found that overall bird abundance decreased when the WHMP was implemented, both prior to and when NSMTS became operational. Consequently, the frequency and severity of nuisance issues (i.e., birds defecating on equipment) at the NSMTS site decreased. Also, the wildlife hazards to aircraft operating in and out of LaGuardia Airport were reduced.

Gulls are commonly found in highly urbanized areas (typically those adjacent to marine environments), and these birds can be a nuisance as well as posing a risk to aircraft safety (Belant et al. 1993, Rock 2005, Washburn 2012). Among the 4 species of gull (Laridae) observed during the study, ring-billed gulls were the most abundant, followed by herring gulls. Ring-billed gulls are present only during the fall and winter months in the New York City area, whereas herring gulls are typically found throughout the year (Washburn et al. 2013). Not unexpectedly, this pattern was evident in the bird survey information collected during our study. Wildlife mitigation activities focused on gulls during Phases II and III, which appeared to have effectively reduced the abundance of these species at the NSMTS site.

Laughing gulls are found in the New York City area only during the summer (e.g., breeding season) and the only known colony is located near John F. Kennedy International Airport, approximately 18.5 km from the NSMTS site (Washburn et al. 2012). We documented a large increase in the abundance of laughing gulls during Phase III of the study. Although it is possible that the operation of the waste transfer station resulted in this change, we believe an unknown biological variable, independent of operations at NSMTS, such as an increase in a naturally occurring food resource (Washburn et al. 2013), likely resulted in the increased abundance of laughing gulls.

Rock pigeons are common in highly urbanized areas, and this species' use of waste transfer stations and other locations results in nuisance issues as well as human health and safety concerns (Weber 1979, Williams and Corrigan 1994). Rock pigeons were frequently mitigated during the WHMP, and their overall abundance at the site declined accordingly during Phases II and III.

European starlings and house sparrows were among the most frequently observed bird species throughout the study. In addition to posing a risk to safe aircraft operations, these birds cause a variety of nuisance and public health concerns associated with nest building, defecation, and disease transmission to humans and other birds (Feare 1984, Linz et al. 2007). Similarly, Washburn (2012) found that these birds commonly used waste management facilities as nesting, foraging, and loafing sites. Although they were frequently dispersed during wildlife mitigation activities, their abundance was similar during all 3 phases of the study. Consequently, we suggest that additional methods of damage mitigation, such as lethal removal of problematic individuals, might be more effective to reduce the presence of these birds.

Many bird species, such as geese, ducks, and waterbirds, were present at the NSMTS site not because of the waste transfer station, but due to the marine aquatic environment. These birds were not attracted to the waste transfer station as a food source or as a nesting location, but given the proximity of the location to LaGuardia Airport, their presence and high abundance presents a risk to safe aircraft operations. Wildlife mitigation activities (primarily nonlethal hazing but some lethal removals) directed toward these species greatly reduced their abundance during Phases II and III. Consequently, the wildlife mitigation program increased air safety at LaGuardia Airport.

Overall, we found that the proportion of birds that are considered to be of a "high," "very high," and "extremely high" hazard (severity) level (based on the analyses of Dolbeer and Wright [2009]) were reduced during Phases II and III. We attribute these reductions to the wildlife mitigation activities that were conducted toward bird species considered to pose a higher level of risk to safe aircraft operations at LaGuardia Airport (Dolbeer and Wright 2009, DeVault et al. 2011).

Management implications

Our findings suggest that implementing a WHMP, in addition to a fully enclosed building design for waste transfer stations, is an effective approach for reducing the presence and abundance of wildlife that pose a hazard to aviation and/or nuisance issues. We suggest

that future research might focus on the efficacy of the various components within a WHMP as related to specific bird species of interest.

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