ELSEVIER

Landscape and Urban Planning 37 (1997) 223–233

LANDSCAPE AND URBAN PLANNING

Bird and small mammal abundance at four types of waste-management facilities in northeast Ohio

Steven W. Gabrey [1]

US Department of Agriculture, National Wildlife Research Center, 6100 Columbus Avenue, Sandusky, OH 44870, USA

Received 29 July 1996; accepted 25 September 1996

Abstract

Location of waste-management facilities in urban and suburban areas is increasingly controversial for a variety of reasons. Because traditional putrescible-waste landfills often attract large numbers of gulls (*Larus* spp.) and other birds, they can present a significant risk to air-traffic safety when located near airports. The Federal Aviation Administration (FAA) provides recommendations for the location of putrescible-waste landfills and other waste-management facilities near airports because of the potential for bird–aircraft collisions.

To extend the life of traditional putrescible-waste landfills, many communities are turning to non-traditional waste-management facilities such as yard-waste compost facilities, construction and demolition landfills, and trash-transfer stations. These types of facilities may present potential bird-strike risks, and may attract nuisance birds such as starlings (*Sturnus vulgaris*) and rock doves (*Columba livia*), and nuisance mammals such as Norway rats (*Rattus norvegicus*). Objective data are needed on bird and mammal use of these facilities for wildlife biologists to advise regulatory agencies and local governments on the siting and management of these facilities.

From May 1993 to April 1994, we compared bird species and numbers at five non-traditional waste-management facilities of three types in northeastern Ohio with species and numbers at a vacant lot (control site) and at a major putrescible-waste landfill. We also surveyed small mammal species and numbers at two compost facilities, a vacant lot, and a small wooded lot. Bird abundance at the five facilities was no different than, or less than, at the vacant lot. About 350 times more birds were seen per observation at the putrescible-waste landfill than at the other five waste-management facilities. Bird use of these non-traditional waste-management facilities appears to be influenced much more by the type of habitat or land-use surrounding the facility than by the waste itself. Fewer small mammals were caught at the compost facilities than at the vacant lot and wooded area. Thus, these non-traditional waste-management facilities do not appear to attract birds or small mammals at higher than background levels and would not pose a significant nuisance problem to the community or be a hazard to aircraft if located near airports.

Keywords: Bird–aircraft collision; Landfill; Nuisance animals; Urban planning; Waste management

1. Introduction

Location of waste-management facilities in urban and suburban and environments is increasingly controversial, partly because of several wildlife-related

[1] Present address: School of Forestry, Wildlife and Fisheries, Louisiana State University, Baton Rouge, LA 70803, USA. Tel.: (419) 625-0242; fax: (419) 625-8465.

PII S0169-2046(96)00352-0

concerns. First, traditional putrescible-waste landfills often attract large numbers of gulls and other birds (Burger and Gochfeld, 1983; Patton, 1988; Belant et al., 1993, 1995). Landfills can present a significant risk to air traffic safety if located near an airport (Cogswell, 1974). In response to the concern over bird–aircraft collisions, the Federal Aviation Administration (FAA) issued Order 5200.5A in 1990 to recommend that putrescible-waste landfills and other waste-management facilities not be located within 1.5 km of runways used by piston-powered aircraft and within 3 km of runways used by turbine-powered aircraft. Order 5200.5A also recommends against locating any waste-management facility from 3 to 8 km of an airport if the facility "attracts or sustains hazardous bird movements from feeding, water or roosting areas into, or across the runways and/or approach and departure patterns of aircraft".

In addition, birds associated with landfills can pose other problems for the surrounding community. For example, gulls often establish colonies on roofs near putrescible-waste landfills (Belant, 1993; Gabrey et al., 1993). Roof-nesting gulls are often considered a nuisance and economic liability because they peck holes in roofs, attack pedestrians, and defecate on cars and buildings; and because feathers, nest material, and food remains may plug drains. Gulls carry bacteria (e.g. *Salmonella*, *Campylobacter*, and *Listeria*) that cause enteric disease in humans (Butterfield et al., 1983; Monaghan et al., 1985; Quessey and Messier, 1992). There is evidence that the water quality of reservoirs can be reduced by large numbers of roosting gulls (Gould and Fletcher, 1978; Smith, 1992). Other nuisance birds associated with landfills, e.g. rock doves (*Columba livia*), European starlings (*Sturnus vulgaris*), and house sparrows (*Passer domesticus*), are reported to carry more than 60 diseases transmissible to humans and domestic animals (Weber, 1979).

Finally, there is some concern regarding the presence of rodents at waste-management facilities. Small mammals are prey to many bird species (Baker and Brooks, 1981; Johnsgaard, 1990), particularly raptors, which can be a risk to air traffic because of their large size and soaring behavior. Also, the presence of commensal rodents such as Norway rats (*Rattus norvegicus*) is a concern because of the possibility of transmitting disease to humans.

Non-traditional waste-management facilities such as yard-waste compost facilities, construction and demolition landfills, and trash-transfer stations are becoming more common because of state and local regulations intended to promote recycling and extend the life of traditional landfills. As few data exist on gull use of the various types of non-traditional waste-management facilities, FAA currently subjects all types of waste-management facilities to Order 5200.5A. The attractiveness of these facilities to other nuisance birds and rodents is not well documented. Therefore, objective data on bird and rodent use of these facilities are needed for wildlife biologists to advise regulatory agencies and local governments on the siting and management of these facilities.

From May 1993 through April 1994, we compared bird and small mammal species and numbers at five non-traditional waste-management facilities (two yard-waste compost facilities, a construction and demolition landfill, and two trash-transfer stations) with species and numbers at a vacant lot (control) and at a major putrescible-waste landfill in northeastern Ohio.

2. Study areas

All seven study sites are within Cuyahoga County, Ohio (Fig. 1). The Control site is a 3.6-ha vacant lot in Glen Willow bordered on three sides by woods and on one side by a road. Vegetation is mostly grasses and forbs, with a 50-m-long hedgerow of willows (*Salix* spp.). The other comparison site, the 36.4-ha Cuyahoga Regional Sanitary Landfill (CRS Landfill) in Solon receives about 2000 t of trash, including putrescible waste, each day. The working face is usually about 0.5 ha.

The 1.2-ha Solon City Compost Facility (SC Compost) is about 1 km from CRS Landfill. SC Compost, bordered by mowed lawns and parking lots, receives yard-waste material (lawn clippings, leaves, wood chips). Kurtz Brothers Composting, Inc. (KB Compost), in Valley View, also receives yard-waste material. The 2.2 ha site is bordered by woods on three sides and a major road on one side. Boyas Construction and Demolition Landfill (Boyas C and D) is about 0.5 km from KB Compost in

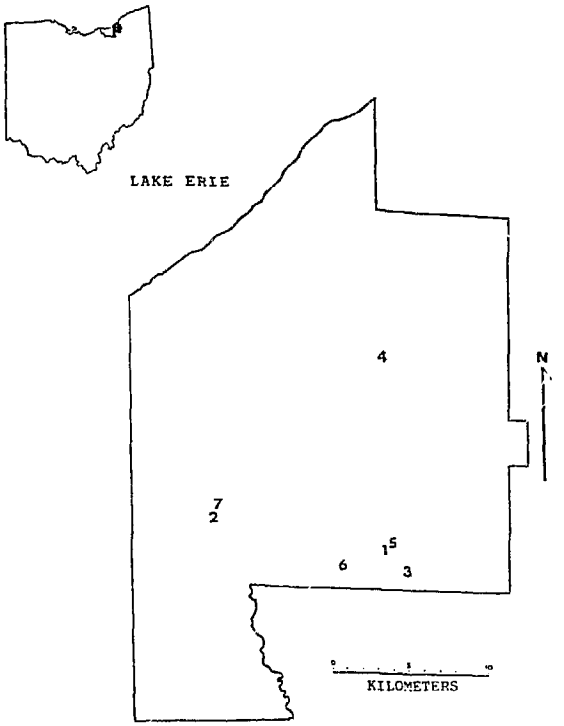

Fig. 1. Map of the eastern half of Cuyahoga County, Ohio, showing location of Cuyahoga Regional Sanitary Landfill (1); Boyas Construction and Demolition (2); Control (vacant lot) (3); Pepper Pike Trash-transfer Station (4); Solon City Compost (5); Northern Ohio Waste Systems Trash-transfer (6); Kurtz Brothers Compost (7).

Valley View. The 2.8-ha area, bordered by woods, a parking lot, and an open unvegetated area, receives construction and demolition waste (cement chunks, soil). The Pepper Pike Trash Transfer Station (PP Trash-transfer) consists of a 3-ha parking lot and building in Pepper Pike. Small covered trucks bring household garbage inside the building through one of two garage doors for unloading and sorting. Garage doors are usually left open, but exposed or loose garbage is rarely visible. The site is bordered by mowed lawns, a parking lot, and woods. The Northern Ohio Waste Systems Trash Transfer Station (NO Trash-transfer), in Oakwood, consists of a 0.6-ha building and 2-ha parking lot. Garbage is delivered in tarp-covered semi-trucks or standard garbage trucks, and unloaded and sorted in one of 10 bays. Exposed garbage inside the building is often visible from outside the building. There are usually five to ten unused empty trailers, some covered and some not, parked outside the bays. The facility is bordered by a parking lot, mowed grass, and woods with a narrow drainage ditch lined with cattails (*Typha* spp.). CRS Landfill, SC Compost, KB Compost, Boyas C and D, and NO Trash-transfer are in industrial parks; PP Trash-transfer is in a residential area; the Control site is in an undeveloped residential area.

3. Methods

3.1. Small mammals

Small mammal trapping was conducted from 15 to 18 February and 7–10 September 1994 at SC Compost and the Control site; and from 15 to 18 February 1994 at KB Compost and in the surround-

Table 1
Number and species of small mammals captured at two yard-waste compost facilities and two comparison sites, Cuyahoga County, Ohio, 1994

Location	Date	Number captured		Capture rate [a]	
		Blarina [b]	*Peromyscus* [c]	*Blarina* [b]	*Peromyscus* [c]
Control	15–18 Feb.	9	1	4.0	0.4
	7–10 Sept.	3	0	0.3	0
SC Compost	15–18 Feb.	0	0	0	0
	7–10 Sept.	0	1	0	0.4
KB Compost	15–18 Feb.	0	0	0	0
KB Woods	15–18 Feb.	0	7	0	3.1

[a] Number of animals caught/number of trap nights × 100.
[b] *Blarina brevicauda.*
[c] *Peromyscus leucopus.*

Table 2
Bird species and numbers recorded flying over or present during 306 5-min observation periods at each of five non-traditional waste-management facilities and a control site in Cuyahoga County, Ohio, May 1993–April 1994

Species	Percent of observation periods recorded	Total birds	Percent of birds present on site
Northern Ohio Trash-transfer			
European starling	69	2908	71
Red-winged blackbird	37	576	87
House sparrow	26	314	90
Ring-billed gull	7	223	80
Other (24 species)		534	44
All birds		4555	72
Pepper Pike Trash-transfer			
European starling	17	580	1
House sparrow	49	571	53
American crow	23	151	32
Other (23 species)		459	4
All birds		1761	21
Solon City Compost			
Ring-billed gull	38	1398	9
European starling	33	520	3
Herring gull	19	287	1
American crow	32	206	41
Mourning dove	17	160	43
Canada goose	3	151	0
Unidentified gull	6	147	0
Other (23 species)		280	24
All birds		3149	9
Kurtz Brothers Compost			
European starling	13	155	3
Herring gull	9	141	0
Blue jay	12	105	5
Snow bunting	< 1	100	100
Other (32 species)		704	21
All birds		1205	22
Boyas Construction and Demolition			
Unidentified gull	2	130	0
Herring gull	8	107	0
Other (34 species)		782	13
All birds		1019	10
Control (vacant lot)			
Ring-billed gull	13	886	0
European starling	22	497	6
Chimney swift	20	278	< 1
American crow	19	263	0
Red-winged blackbird	21	238	71
Herring gull	10	220	0
American goldfinch	16	119	42
Unidentified gull	5	117	0
Boyas Construction and Demolition			
Blue jay	18	111	9
Song sparrow	22	108	98
American robin	16	104	52
Other (47 species)		658	37
All birds		3599	18

ing woods (KB Woods). We used Victor® mouse and Victor® rat traps baited with a mixture of peanut butter, oats, and dog food. On the day 1 of the trapping period, one rat and one mouse trap were placed 1 m apart at 30 stations at each site. Stations, marked with survey flags, were about 10 m apart. Traps were checked daily, reset with new bait, and moved 4–5 m after recording trap status (sprung, unsprung) and species caught.

Capture rate was defined as the number of animals caught/number of trap nights × 100. Traps that were missing, sprung, or held an animal were counted as 0.5 trap nights; unsprung traps were counted as one trap night.

3.2. Birds

At CRS Landfill, we obtained a point estimate of the number of gulls and other birds present at two elevation (on the ground or within 30 m of the ground, and flying over the landfill at over 30 m) twice a day, three times each week. Although the time required for each count varied (5–20 min), the completed estimate was assumed equal to the number of birds present at the landfill at the time the count was started.

Bird observations at the other six sites were conducted in random order on one randomly chosen day each week. Observers, situated such that the entire site was visible, recorded bird numbers and species for six consecutive 5-min intervals. Birds were placed into one of four categories: (1) flying over but not landing; (2) landing or present on site but not on the waste; (3) landing or present on but not feeding or collecting nest material from the waste; (4) feeding on or obtaining nest material from the waste.

Table 3
Number of birds observed flying over or present at facility and percent of those birds feeding or collecting nest material at five waste disposal facilities and a control site in Cuyahoga County, Ohio. Each site was observed for six consecutive 5-min intervals on 51 days from May 1993–April 1994

Facility	Mean number of birds per 5 min			Percent of birds landing or present that fed/collected nest material	Percent of total birds that fed/collected nest material
	Flying over [a]	Landing or present on facility [b]	Total [c]		
NO Trash-transfer	4.2B	10.7A	14.9A	7	5
Control (vacant lot)	9.6A	2.2B	11.8A	–	–
SC Compost	9.4A	0.9BCD	10.3AB	16	1
PP Trash-transfer	4.6B	1.2BC	5.8BC	4	1
KB Compost	3.1B	0.9CD	3.9C	1	< 0.1
Boyas Const. and Dem.	3.0B	0.3D	3.4C	1	< 0.1
Total (except Control)	3.2	4.5	7.7	6	2

[a] There was a difference among facilities (ANOVA on log[$X + 1$] transformed data, $P = 0.01$; $F = 8.93$; d.f. = 5,300); means followed by the same letter are not different ($P > 0.05$), Tukey test.
[b] There was a difference among facilities (ANOVA on log[$X + 1$] transformed data, $P < 0.01$; $F = 32.27$; d.f. = 5,300); means followed by the same letter are not different ($P > 0.05$), Tukey test.
[c] There was a difference among facilities (ANOVA on log[$X + 1$] transformed data, $P < 0.01$; $F = 14.53$; d.f. = 5,300); means followed by the same letter are not different ($P > 0.05$), Tukey test.

Because any 5-min observation period was not independent of the previous period, we obtained the mean number of birds per 5-min period for each observation day at each site. These daily means were then log-transformed (Zar, 1984) and subjected to one-way ANOVA with Tukey multiple comparison tests using the GLM procedure (Statistical Analysis Systems Institute Inc., 1988). Because gulls are of particular concern to the FAA, analyses were conducted for all bird species and for gulls only. Com-

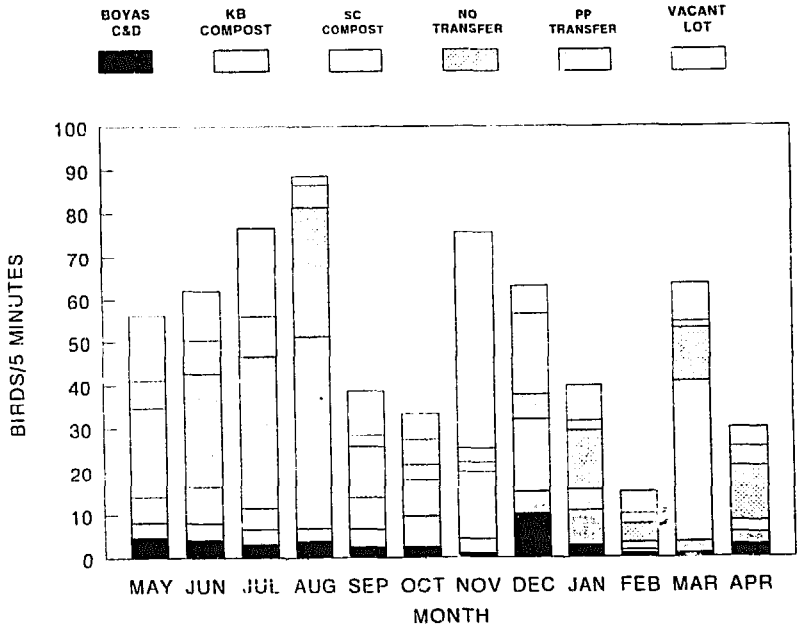

Fig. 2. Monthly mean number of birds observed flying over and present on site per 5-min period at five non-traditional waste-management facilities and a control site in Cuyahoga County, Ohio, May 1993–April 1994.

mon and scientific names of all bird species recorded are listed in Appendix A.

4. Results

4.1. Small mammals

No small mammals were caught at KB Compost, whereas seven whitefooted mice (*Peromyscus leucopus*) were caught in the surrounding woods in February (Table 1). Only one white-footed mouse was caught at SC Compost, and one white-footed mouse and nine short-tailed shrews (*Blarina brevicauda*) were caught at the Control site during February and September combined (Table 1). No evidence of larger mammals (e.g. feral dogs or cats) that are not sampled by mouse or rat traps was observed.

4.2. Birds

At the five non-traditional waste-management facilities (SC Compost, Boyas C and D, KB Compost, PP Trash-transfer and NO Trash-transfer) we recorded 11 689 birds of 49 species on 1530 5-min observations over 51 days, or 7.7 birds per observation. At the Control site, we recorded 3599 birds of 57 species on 306 5-min observations over 51 days (Table 2), or 11.8 birds per observation. The most abundant species were European starlings at KB Compost, NO Trash-transfer, and PP Trash-transfer; ring-billed gulls (*Larus delawarensis*) at SC Compost and Control site; and unidentified gulls (ring-billed and herring (*Larus argentatus*)) at Boyas C and D (Table 2). The fewest total birds were observed at Boyas C and D; the most total birds at NO Trash-transfer.

At Boyas C and D, KB Compost, and PP Trash-transfer, less than 5% of all birds landing or present on site were observed feeding on, or collecting nest material from, the waste material (Table 3). At SC Compost, 16% (44/279) of the birds landing or present within the facility were observed feeding or collecting nest material. Thirty-three of these 44 were American crows (*Corvus brachyrhynchos*), apparently feeding on acorns in composting leaf piles. At NO Trash-transfer, 7% (221/3258) of the birds landing or present within the facility were observed feeding or collecting nesting material. Sixty-four percent of these were ring-billed gulls.

Table 4
Number of gulls (herring, ring-billed, and unidentified) observed per 5-min period (landing or present within facility plus flying over) at five waste disposal facilities and a control site in Cuyahoga County, Ohio. Each site was observed for six consecutive 5-min intervals on 51 days from May 1993 to April 1994

Facility	Mean number of gulls per 5 min period		
	Flying over	Landing or present on facility	Total [a]
SC Compost	5.9	0.1	6.0A
Control (vacant lot)	4.0	0.0	4.00B
NO Trash-transfer	0.3	0.6	0.9BC
Boyas Const. and Dem.	0.9	0.0	0.9BC
KB Compost	0.8	0.0	0.8BC
PP Trash-transfer	0.3	0.0	0.3C

[a] There is a difference among means (ANOVA on $\log[X+1]$ transformed data, $P < 0.01$; $F = 12.31$; d.f. = 5,300). Means followed by the same letter are not different ($P > 0.05$), Tukey test.

The number of birds observed flying over varied among facilities ($P = 0.01$; range 3.0–9.6 birds per 5-min period; not including CRS Landfill), as did the number of birds observed landing or present within the facility ($P < 0.01$; range 0.3–10.7 birds per 5-min period), and total number of birds ($P < 0.01$; range 3.4–1.9 birds per 5-min period; Table 3). Overall, NO Trash-transfer showed the highest activity; Boyas C and D showed the lowest.

Gulls (herring, ring-billed, and unidentified) were more abundant (landing or present on site + flying over) at SC Compost than at Boyas C and D, KB Compost, NO Trash-transfer, PP Trash-transfer, or the Control site ($P < 0.01$; Table 4). Of the 1398 ring-billed gulls observed at SC Compost, only 9% were observed landing or present, and none were feeding. Gulls were observed on site elsewhere only at NO Trash-transfer, where on 2 days, a total of 142 were observed feeding on garbage spilled in the parking lot.

Total birds observed per 5-min period varied seasonally. In general, more birds were present during late summer and early winter (Fig. 2).

At the putrescible-waste landfill (CRS Landfill), we recorded 805 684 birds of 41 species during 300 observations (Table 5), or 2686 birds per observa-

Table 5
Bird species and numbers recorded at the Cuyahoga Regional Sanitary Landfill during 300 observations, Cuyahoga County, Ohio, May 1993–April 1994

Species	Total birds	Percent of birds present on ground or within 30 m of ground
Ring-billed gull	553651	> 99
Herring gull	175258	> 99
European starling	51095	100
American crow	18370	100
Unidentified gull	2385	0
Canada goose	2244	100
Turkey vulture	1515	3
Great black-backed gull	763	100
Tundra swan	137	100
Other (33 species)	266	100
All birds	805684	> 99

tion. This was 349 times the mean number of birds recorded (7.7) at the five other waste-management facilities. Ninety-one percent of all birds observed at CRS Landfill were gulls. We estimated a mean of 2438 gulls per observation at CRS Landfill compared with six gulls or less per observation at the five other waste-management facilities.

3. Discussion

Numbers of small mammals captured at the two compost facilities during the limited trapping program were low, suggesting that such compost facilities would not serve as focal points for rodent populations. In an earlier study, overall numbers of small mammals were similar at compost and control sites, although relatively high numbers of Norway rats were detected at those sites located in an urban setting (Gabrey et al., 1994). The authors concluded that rats may use compost facilities if a population already exists in the surrounding area. In the present study, however, no rats were captured, possibly because these sites were in rural or suburban settings where commensal rodents are less likely to occur. Presence of rodents at compost facilities probably depends on the rodent populations of the surrounding areas. Therefore, individual compost facilities should be monitored for rodent activity, and control programs implemented when necessary.

Birds did not appear to be attracted to any of the non-traditional waste-management facilities as evidenced by the small number of birds at the sites and the small percentage feeding or collecting nesting material from the waste (5% or less of all birds observed at each site). Less than 1% of all birds observed at each of the two compost facilities (SC Compost and KB Compost) were observed feeding on compost. An earlier study (Gabrey et al., 1994) also found minimal feeding activity at compost facilities. At SC Compost, 16% (44/271) of birds landing or present within the facility, primarily American crows, were observed feeding or collecting nest material, compared with less than 1% (2/261) at KB Compost. The abundance of crows at SC Compost was likely influenced by the site's proximity to CRS Landfill, where 61 crows per observation were recorded. Crows were often observed feeding on acorns at compost facilities in New Jersey, where bird use of the facilities also appeared influenced by the proximity of the facilities to putrescible-waste landfills (Caccamise et al., 1992).

None of the waste-management facilities (except for CRS Landfill) appeared to attract large numbers of gulls. Small numbers of gulls (less than one gull per observation) were observed on the ground at only two sites (NO Trash-transfer and SC Compost), and were feeding at only one of these. A previous study of yard-waste compost facilities in northern Ohio also found that compost facilities did not attract gulls (Gabrey et al., 1994). Proximity to CRS Landfill, where over 2400 gulls were recorded during each observation, probably influenced gull numbers at SC Compost. Gulls were observed feeding at NO Trash-transfer on two occasions when garbage was unintentionally spilled in the parking lot. While these were unusual occurrences, they demonstrate the need for maintaining sanitary conditions at trash-transfer stations.

More birds were recorded at the NO Trash-transfer station than at any other site (except CRS Landfill). Seventy-two percent of all birds there landed on site, although only 5% of all birds observed were feeding on waste material. This facility is bordered by a small drainage ditch with cattails which supports a large number of roosting starlings and red-

winged blackbirds (*Agelaius phoeniceus*). These two species together comprised 77% (3484/4555) of all birds recorded, and 35% (78/221) of all birds feeding at the facility. Birds rarely were seen flying inside the building, and those recorded feeding were usually inside uncovered truck-trailers parked outside the building. Total bird activity at NO Trash-transfer was highest during late spring and early summer when red-winged blackbirds were nesting in the nearby cattails. Fewer birds were observed at PP Trash-transfer than at NO Trash-transfer, most likely because there was no adjacent wetland, PP Trash-transfer handled a smaller volume of trash, and all trucks carrying trash were only uncovered when inside the building. Most birds observed at trash-transfer facilities in New Jersey were not attracted to, or part of, the transfer process, but rather were components of the natural surrounding communities (Caccamise et al., 1992).

One killdeer (*Charadrius vociferous*) was observed pecking at gravel at Boyas C and D, where 10% (98/1019) of all birds observed landed or were present within the facility. American goldfinches (*Carduelis tristis*) were often numerous in the shrubs bordering the facility, and bank swallows (*Riparia riparia*) nested in a sand cliff at one end of the facility. Birds observed at a construction and demolition landfill in New Jersey also appeared to be associated to the habitat surrounding the landfill (Caccamise et al., 1992).

Of the six sites (excluding CRS Landfill), the number of birds flying over per 5-min period was highest at the Control and at NO Trash-transfer. Only at NO Trash-transfer was there significantly more birds observed landing or present within the facility per 5-min period than at the Control site. In comparison, about 349 times more birds were seen per observation at CRS Landfill than at the other five waste-management facilities.

In conclusion, bird use of these trash-transfer, compost, and construction and demolition facilities appears to be influenced much more by the type of habitat or land-use (wetland, landfill) surrounding the facility than by the waste itself or the activities associated with disposal or handling of the waste. These sites do not appear to attract birds or small mammals at higher than background levels. Such sites would probably not pose a greater hazard to aircraft, or create more nuisance bird or rodent problems than would vacant lots or open field habitat.

Acknowledgements

Sponsorship and funds for this study were provided by the Federal Aviation Administration, Office of Airports Safety and Standards, Washington, D.C., and Airports Division, Airport Technology Branch, FAA Technical Center, Atlantic City International Airport, New Jersey. T.A. Haaf (Cuyahoga Regional Sanitary Landfill), E. Janez (Kurtz Brothers Compost Facility), M. Boyas (Boyas Construction and Demolition Landfill), E. Butler (Solon City Compost Facility), C. Appesella (Control site), J. Bowman (Northern Ohio Waste Systems Trash-transfer Station), and R. Balser (Pepper Pike Trash-transfer station) provided access to their facilities. Thanks to G.E. Bernhardt, E.J. Bly, J.C. Hovis, S.K. Ickes, K.D. Madaras, M.R. Rutger, T.W. Seamans, and P.P. Woronecki for field assistance. J.L. Belant and R.A. Dolbeer developed the study protocol. R.A. Dolbeer and two anonymous reviewers offered valuable improvements on earlier drafts.

Appendix A

Common and scientific names of all bird species encountered, and facilities at which they were observed, Cuyahoga County, Ohio, May 1993–April 1994.

Species	Facility(s)where observed[a]
European starling (*Sturnus vulgaris*)	1,2,3,4,5,6,7
Red-winged blackbird (*Agelaius phoeniceus*)	1,2,3,4,5,6,7
House sparrow (*Passer domesticus*)	1,2,3,4,5,6,7
Mourning dove (*Zenaida macroura*)	1,2,3,4,5,6,7
Turkey vulture (*Cathartes aura*)	1,2,3,4,5,6,7
Barn swallow (*Hirundo rustica*)	1,2,3,4,5,6,7
Chimney swift (*Chaetura pelagica*)	1,2,3,4,5,6,7
American crow (*Corvus brachyrhynchos*)	1,2,3,4,5,6,7
Common grackle (*Quiscalus quiscula*)	1,2,3,4,5,6,7
Red-tailed hawk (*Buteo jamaicensis*)	1,2,3,4,5,6,7
Ring-billed gull (*Larus delawarensis*)	1,2,3,4,5,6,7
Herring gull (*Larus argentatus*)	1,2,3,4,5,6,7
Brown-headed cowbird (*Molothrus ater*)	1,2,3,4,5,6,7
Tree swallow (*Tachycineta bicolor*)	1,2,3,5,6,7
Song sparrow (*Melospiza melodia*)	1,2,3,5,6,7
Killdeer (*Charadrius vociferus*)	1,2,3,5,6,7
Northern flicker (*Colaptes auratus*)	2,3,4,5,6,7
House finch (*Carpodacus mexicanus*)	2,3,4,5,6,7
American robin (*Turdus migratorius*)	2,3,4,5,6,7
American goldfinch (*Carduelis tristis*)	2,3,4,5,6,7
Blue jay (*Cyanocitta cristata*)	2,3,4,6,7
Great black-backed gull (*Larus marinus*)	1,2,3,5,7
Rough-winged swallow (*Stelgidopteryx serripennis*)	1,2,4,5,7
Rock dove (*Columba livia*)	3,4,5,6,7
American kestrel (*Falco sparverius*)	1,2,5,6,7
Canada goose (*Anser canadensis*)	1,2,3,5,6
Northern cardinal (*Cardinalis cardinalis*)	2,3,4,7
Mallard (*Anas platyrhynchos*)	1,3,4,6
Indigo bunting (*Passerina cyanea*)	2,3,6,7
Belted kingf isher (*Ceryle alcyon*)	1,4,5
Cooper's hawk (*Accipiter cooperii*)	3,5,7
Red-bellied woodpecker (*Melanerpes carolinus*)	2,3,7
Cedar waxwing (*Bombycilla cedrorum*)	2,3,4
Bank swallow (*Riparia riparia*)	2,3,5
Eastern phoebe (*Sayornis phoebe*)	2,3
Great blue heron (*Ardea herodius*)	1,3
Northern oriole (*Icterus galbula*)	3,7
Gray catbird (*Dumetella carolinensis*)	3,7
Black-capped chickadee (*Parus atricapillus*)	3,7
Eastern bluebird (*Sialia sialis*)	3,7
Hairy woodpecker (*Picoides villosus*)	2,4
Downy woodpecker (*Picoides pubescens*)	3,4

Dark-eyed junco (*Junco hyemalis*)	2,3
Lesser black-backed gull (*Larus fuscus*)	1
Long-billed dowitcher (*Limnodromus scolopaceus*)	1
Spotted sandpiper (*Actitis macularia*)	1
Glaucous gull (*Larus hyperboreus*)	1
Caspian tern (*Sterna caspia*)	1
Lesser scaup (*Aythya affinis*)	1
Tundra swan (*Cggnus columbianus*)	1
Bufflehead (*Bucephala albeola*)	1
American coot (*Fulica americana*)	1
Blue-winged teal (*Anas discors*)	1
Buddy duck (*Oxyura jamaicensis*)	1
Snow goose (*Chen caerulescens*)	1
Horned grebe (*Podiceps auritus*)	1
Bald eagle (*Halieeatus leucocephalus*)	1
Bonaparte's gull (*Larus philadelphia*)	1
Dunlin (*Calidris alpina*)	1
Franklin' s gull (*Larus pipixcan*)	1
Horned lark (*Eremophila alpestris*)	1
Wood duck (*Aix sponsa*)	2
Red-headed woodpecker (*Melanerpes erythrocephalus*)	2
Merlin (*Falco columbarius*)	3
Rufous-sided towhee (*Pipilo erythrophthalmus*)	3
Yellow-bellied sapsucker (*sphryapicus varius*)	3
Common nighthawk (*Chordeiles minor*)	3
Common yellowthroat (*Geothlypis trichas*)	3
Chipping sparrow (*Spizella passerina*)	3
Eastern kingbird (*Tyrannus tyrannus*)	3
Field sparrow (*Spizella pusilla*)	3
Least flycatcher (*Empidonax minimus*)	3
Willow flycatcher (*Empidonax traillii*)	3
American tree sparrow (*Spizella arborea*)	3
Tufted titmouse (*Parus bicolor*)	3
Vesper sparrow (*Pooecetes gramineus*)	3
White-throated sparrow (*Zonotrichia albicollis*)	3
Merlin (*Falco columbarius*)	3
Red-shouldered hawk (*Buteo lineatus*)	3
White-breasted nuthatch (*Sitta carolinensis*)	3
Yellow-rumped warbler (*Dendroica coronata*)	3
Sharp-shinned hawk (*Accipiter striatus*)	5
House wren (*Troglodytes aedon*)	6
Yellow warbler (*Dendroica petechia*)	6
Snow bunting (*Plectrophenax hyperboreus*)	7
Pileated woodpecker (*Dryocopus pileatus*)	7

[a] 1, Cuyahoga Regional Sanitary Landfill; 2, Boyas Construction and Demolition; 3, Control (vacant lot); 4, Pepper Pike Trash-transfer Station; 5, Solon City Compost; 6, Northern Ohio Waste Systems Trash-transfer Station; 7, Kurtz Brothers Compost.

References

Baker, J.A. and Brooks, R.J., 1981. Raptor and vole populations at an airport. J. Wildl. Manage., 45: 390–396.

Belant, J.L., 1993. Nest-site selection and reproductive biology of roof- and island-nesting herring gulls. Trans. N. Am. Wildl. Nat. Resour. Conf., 58: 78–86.

Belant, J.L., Seamans, T.W., Gabrey, S.W and Ickes, S.K., 1993. Importance of a landfill to nesting herring gulls. Condor, 95: 817–830.

Belant, J.L., Seamans, T.W., Gabrey, S.W., and Dolbeer, R.A., 1995. Gull and other bird abundance at landfills in northern Ohio. Am. Midl. Nat., 134: 30–40.

Burger, J. and Gochfeld, M., 1983. Behavior of nine avian species at a Florida garbage dump. Col. Waterbirds, 6: 54–63.

Butterfield, J., Coulson, J.C., Kearsey, S.V., Monaghan, P., McCoy, J.H. and Spain, G.E., 1983. The herring gull *Larus argentatus* as a carrier of Salmonella. J. Hygiene, 91: 429–436.

Caccamise, D.F., Reed, L. and Dosch, J.J., 1992. Bird use of waste management facilities (Task I). Part V: Bird studies at waste processing facilities in New Jersey. Interim Rep. DTFA01-91-Z-02004, US Dep. Transport., Fed. Aviation Admin. Tech. Center, Atlantic City International Airport, NJ.

Cogswell, H.L., 1974. Ecological factors in the hazard of gulls to aircraft in a bayside complex of airports and solid waste landfills. In: S.A. Gauthreaux, Jr. (Editor), Proc. Conf. on the Biological Aspects of the Bird/aircraft Collision Problem. Clemson University, Clemson, SC, pp. 27–108.

Gabrey, S.W., Seamans, T.W. and Ickes, S.K., 1993. Bird use of waste-management facilities (Task I). Part I. Importance of a landfill to a roof-nesting colony of herring and ring-billed gulls in northeastern Ohio. Interim Rep. DTFA01-91-Z-02004, US Dep. Transport., Fed. Aviation Admin., Tech. Center, Atlantic City International Airport, NJ.

Gabrey, S.W., Belant, J.L., Dolbeer, R.A. and Bernhardt, G.E., 1994. Bird and rodent abundance at yard-waste compost facilities in northern Ohio. Wildl. Soc. Bull., 22: 288–295.

Gould, D.J. and Fletcher, M.R., 1978. Gull droppings and their effects on water quality. Water Res., 12: 665–672.

Johnsgaard, P.A., 1990. Hawks, eagles, and falcons of North America. Smithsonian Press, Washington, DC.

Monaghan, P., Shedden, C.B., Ensor, K., Fricker, C.R. and Girdwood, R.W.A., 1985. Salmonella carriage by herring gulls in the Clyde area of Scotland in relation to their feeding ecology. J. Appl. Ecol., 22: 669–680.

Patton, S.R., 1988. Abundance of gulls at Tampa Bay landfills. Wilson Bull., 100: 431–442.

Quessey, S. and Messier, S., 1992. Prevalence of *Salmonella* spp., *Campylobacter* spp., and *Listeria* spp. in ring-billed gulls (*Larus delawarensis*). J. Wildl. Dis., 28: 526–531.

Smith, G.C., 1992. Silver gulls and emerging problems from increasing abundance. Corella, 16: 39–46.

Statistical Analysis Systems Institute Inc., 1988. SAS/STAT User's Guide. Cary, NC.

Weber, W.J., 1979. Health hazards from pigeons, starlings and English sparrows. Thomson Publications, Fresno, CA.

Zar, J., 1984. Biostatistical Analysis. Prentice Hall, Englewood Cliffs, NJ.