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Use of Raptors to Reduce Scavenging Bird Numbers at Landfill Sites

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Abstract

*Scavenging birds at landfill sites carry disease, cause nuisance, and may create a bird-strike hazard. We evaluated the efficacy of trained hybrid falcons (*Falco *spp.) or hawks (*Buteo *spp. and* Parabuteo *spp.) at deterring scavenging gulls and corvids from a series of sites in the United Kingdom. Birds were flown throughout daylight hours, 7 days per week for periods of 7–12 weeks. We conducted our studies in all seasons as gull and corvid populations fluctuated. Although neither raptor group was able to completely eliminate all scavenging birds, bird numbers were reduced more consistently by falcons than by hawks. Based on our research, we recommend that falcons may be more appropriate than hawks for use within integrated bird management strategies to reduce the problems associated with gulls and corvids at landfill sites.* (WILDLIFE SOCIETY BULLETIN 34(4):1162–1168; 2006)

Key words

bird control, Buteo *spp., corvids, deterrence, falconry, falcons,* Falco *spp., gulls, hawks, landfill,* Larus *spp.,* Parabuteo *spp., United Kingdom.*

Landfill sites that accept household and other edible wastes provide extensive feeding opportunities for scavenging birds (Mudge and Ferns 1982, Coulson et al. 1987). Gulls (*Larus* spp.), corvids (carrion crows [*Corvus corone*], rooks [*C. frugilegus*], jackdaws [*C. monedula*]), and starlings (*Sturnus vulgaris*) are the most commonly found birds at sites in the United Kingdom (Baxter 1999).

Gulls are known carriers of human pathogens such as *Salmonella* sp., *Escherichia coli*, and avian botulism (Ortiz and Smith 1994). Corvids may carry West Nile virus (Centers for Disease Control 2003). Water quality may be affected when gulls that feed on landfills roost on nearby water storage reservoirs (Monaghan et al. 1985). Birds that defecate and carry waste off-site also may cause health, nuisance, and amenity hazards to local residents (Watson and Hack 2000). The large numbers of birds that feed on landfills often remain in the vicinity of the site when not feeding and may prove detrimental to local sensitive wildlife via predation or habitat degradation (Bazely et al. 1991). There also is increased risk of bird-strikes with aircraft when landfills are located close to airports. Gulls were responsible for over 42% of all bird-strikes recorded between 1973 and 1982 in the United Kingdom (Horton et al. 1983). Deterring scavenging birds from using landfill sites may, therefore, reduce disease transmission, prevent water pollution, benefit other species, and protect human lives at sites close to airports.

Different species of scavenging birds frequent landfill facilities in the British Isles at different times of year (Baxter 2001). Black-headed gulls (*Larus ridibundus*) and lesser black-backed gulls (*L. fuscus*), may be residents, wintering, summering, or passage migrants in the United Kingdom (Cramp and Simmons 1983, Lack 1986, Wingfield-Gibbons et al. 1993). Herring gulls (*L. argentatus*) and great black-backed gulls (*L. marinus*) are year-round residents whose numbers are supplemented by migratory Scandinavian birds during winter (Bowes et al. 1984). Corvids are predominantly sedentary, although some birds do migrate to different locations during winter (Cramp and Simmons 1994). The majority of individual corvids disperse away from breeding areas to form communal winter roosts numbering many thousands of birds (Lack 1986). Seasonal changes in scavenging gull and corvid numbers were, therefore, considered when determining the efficacy of each deterrent technique.

Trained raptors are frequently used as the basis of integrated bird management regimes at United Kingdom landfill sites (McDonald 2001). The 2 groups of raptor species preferred are hawks (Harris' [*Parabuteo unicinctus*] and red-tailed [*Buteo jamaicensis*]) and falcons (peregrine [*Falco peregrinus*], saker [*F. cherrug*], and lanner [*F. biarmicus*]), and associated hybrids (Sherrod and Fox 1998). Little is known about the overall effectiveness of birds of prey when used independently. Should neither group be effective, their use within integrated strategies that include distress calls, blank shot, pyrotechnics, gas cannons, etc., would be unwarranted.

Hawks are less expensive to purchase and easier to train than falcons (Parry-Jones 1994). Should they be as effective as falcons, their use may be more practicable. Implementation on a 7-days-per-week dawn-to-dusk deterrence regime would cost approximately US$60,000 per annum. In this paper we compare the efficacy of falcons and hawks at deterring scavenging gulls and corvids from landfill sites.

Study Area

We conducted the trials between March 1999 and April 2001 at 4 United Kingdom landfill sites in Devon, Manchester, Merseyside, and West Yorkshire. Two sites were located inland and 2 within 12 miles of the coast. All

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trial sites were over 30 miles apart. Regular daily supplies of household waste (over 250,000 tonnes per annum) were deposited at all sites. Peak counts of at least 2,500 feeding gulls and 500 corvids were observed at all sites. Sites were required to cover waste at the end of each operational day with 150 mm of inert material.

Methods

Gulls and corvids present at the landfill site were targeted by trained birds of prey under Schedule 2 of the 1981 United Kingdom Wildlife and Countryside Act (as amended). Specific licenses were held under section 16 of the Act (WLF5) for targeting black-headed gulls. All falcons and hawks used in these studies were registered with the United Kingdom Department for Environment, Food and Rural Affairs under license number 14008.

We completed falcon trials at 4 landfill sites during autumn (13 Sep–10 Dec 1999), summer (14 Jun–10 Sep 1999), late winter (3 Jan–23 Feb 2001), and spring (20 Mar–2 Jun 2000). We completed hawk trials at 4 sites for between 5 and 9 weeks during summer (10 May–13 Jun 1999), autumn (14 Aug–20 Oct 2000), early winter (9 Oct–3 Dec 1999), and early spring (7 Feb–24 Mar 2000). Each trial consisted of 3–4 weeks of pretreatment monitoring, 7–12 weeks with falcons or hawks being flown, and 3–4 weeks of posttreatment monitoring. Up to 3 falcons or hawks were used each day during treatment periods and flown by an autonomous pest control company. Birds were always flown independently. In general, hawks and falcons were not flown in winds above 33 km/hour and above 46 km/hour, respectively. No birds were flown in rain or fog, although the latter only occurred on one occasion during all trials. We used no other bird deterrence techniques. We implemented deterrence during the trial period for 7 days per week between dawn and dusk. An on-site presence was required between 0400 and 2230 hours during the summer and 0730 to 1630 hours in winter. Two people rotated these duties. We used the same personnel to fly birds at each site.

We monitored scavenging birds between dawn and midday or midday and dusk on 2 randomly selected days each week. We counted gulls and corvids by walking a standard route around the site every hour. We generally observed birds at distances of $<$200 m using 10 $\times$ 42 binoculars or a 20–60$\times$ telescope. We first recorded birds present on the active tipping area. We kept the active tipping area (feeding area) in sight at all times and took note of any movements of birds around the site to avoid double-counting. We included birds that were feeding on covered waste, resting anywhere on-site or in surrounding fields, circling over the site, or bathing in standing water on-site in the analyses. We did not include birds that were feeding in surrounding fields, present in woodland off-site, or flying over the site without circling or stopping in our analyses. We counted flocks of birds using standard estimation methods described in Bibby et al. (2000). If we observed birds resting in the surrounding fields, we included them in our counts as we assumed them to be reliant on the feeding opportunities presented by the landfill. We only excluded birds that were observed foraging in surrounding fields or pasture. The numbers present, therefore, represented the maximum on-site each hour of recording. We replicated monitoring effort throughout the pretreatment, treatment, and posttreatment periods at all sites. We analyzed results by comparing the mean hourly count of birds present during pretreatment and treatment periods at each site.

Because gulls are known to commute $>$50 km between feeding, breeding, and roosting sites (Horton et al. 1983), the numbers of birds present at alternative sites within this radius could be influenced by treatment at the study site. Seasonal changes could not, therefore, be determined by paired site monitoring. We used posttreatment monitoring as an indicator of population changes specific to each study area. Birds present during the posttreatment period however, could be influenced by residual impacts from the treatment period. We therefore used posttreatment data only as an indicator of population change. This article did not investigate the effect of deterring birds from one site on numbers present at another.

Data Analysis

We measured deterrence success by comparing mean hourly numbers before and during treatment at each individual study site. We then used posttreatment values as an indicator of probable population change. We tested changes in bird numbers between pretreatment and treatment periods using Mann–Whitney *U* tests since the data were right skewed with a tendency for a few extreme values. We analyzed data using SPSS® for Windows (Standard Version; SPSS Inc., Chicago, Illinois). We assessed the overall success or failure of the treatment using the following criteria: 1) success—a significant reduction between pre-treatment and treatment period, then posttreatment stability or increase, 2) probable success—no significant reduction during treatment followed by posttreatment increase, 3) failure—increase during treatment, or no change in population between pre-, treatment, and posttreatment periods, and 4) unknown—reductions during treatment followed by continued posttreatment reductions.

We recorded black-headed gulls, lesser black-backed gulls, and herring gulls to species level. Because $<$1% of the total number of gulls present at any of the sites were great black-backed gulls or common gulls (*Larus canus*), we excluded them from the analyses. Rooks, carrion crows, and jackdaws feeding among waste were difficult to separate consistently; thus, we recorded them as "corvids." We determined a total number of successes, probable successes, or failures for both falcons and hawks against each scavenging species or group of species at each site.

Results

We conducted an average of 6.5 falcon flights per day throughout all trials. Each flight involved the handler's being present with a single bird for approximately 1 hour. Length of flight varied between 20 seconds and 40 minutes depending on whether a bird was hunting (pursuit bird) or

Table 1. Mean changes in gull and corvid numbers at 4 landfill sites treated with falcons in the United Kingdom in 1999 and 2001.

Site[a]	Species[b]	Pretreatment population	SE mean	Treatment population	SE mean	Posttreatment population	SE mean	% change during treatment[c]	$P \leq$	Success[d]	n[e]
1	bhg	66.3	10.9	20.9	3.8	937.6	148.1	68.4	0.001	1	165
1	lbb	56.0	8.7	0.9	0.2	0.02	0.02	98.4	0.001	4	140
1	hg	1.2	0.3	0.8	0.2	95.7	18.7	30.2	0.035	1	89
1	cor	108.5	15.7	57.3	5.7	486.2	40.8	47.2	0.019	1	127
2	bhg	163.7	21.5	98.6	13.5	530.5	84.3	39.8	0.001	1	165
2	lbb	291.1	41.2	122.9	16.1	3.2	0.5	57.8	0.001	4	140
2	hg	11.2	1.8	8.9	1.4	418.7	48.6	20.0	0.064	2	89
2	cor	231.3	29.0	102.79	6.2	142.7	11.4	55.6	0.001	1	127
3	bhg	968.0	97.8	15.5	1.8	40.2	11.9	98.4	0.001	1	165
3	lbb	72.7	8.3	4.5	0.9	14.4	3.1	93.8	0.001	1	140
3	hg	718.2	82.4	15.0	2.9	41.5	10.3	97.9	0.001	1	89
3	cor	178.6	25.6	178.6	15.1	202.8	20.2	0.03	0.800	2	127
4	bhg	560.9	58.9	23.3	2.2	151.7	16.2	95.8	0.001	1	165
4	lbb	229.7	47.9	54.0	6.1	168.3	22.3	76.5	0.004	1	140
4	hg	22.6	3.8	20.4	2.3	23.0	3.3	9.7	0.919	3	89
4	cor	215.4	17.0	211.2	9.9	548.4	28.5	1.9	0.980	2	127

[a] Site 1: autumn 1999, West Yorkshire; Site 2: summer 1999, Manchester; Site 3: winter 2001, Merseyside; Site 4: winter 1999, Devon.
[b] bhg = *Larus ridibundus*, cor = Corvidae, hg = *L. argentatus*, lbb = *L. fuscus*.
[c] Percentage reduction in treatment population from pretreatment population.
[d] 1 = success: significant reduction between pretreatment and treatment period with posttreatment stability or increase. 2 = probable success: no significant reduction during treatment but posttreatment increase. 3 = failure: increase during treatment or no change in population between pretreatment, treatment, and posttreatment periods. 4 = unknown: reductions during treatment followed by continued posttreatment reductions.
[e] Number of hours of observation during treatment.

being flown to a lure or circling around the site (deterrence bird). Birds that were flown to a lure would stoop onto a lure swung around the falconer's head, thus giving the impression of a hunting bird. Mean time a bird was in the air was 10.5 minutes. Falcons left the landfill and needed to be retrieved once every 4.34 days. Retrieval time took an average of 209 minutes. Falcons were not flown for an average of once every 10 days because of inclement weather.

The falcons caught 102 corvids, for an average capture rate of 1 every 3 days. Thirty-one gulls were caught, for an average capture rate of 1 every 10 days. Other species including rats ($n = 2$) and other birds ($n = 4$) were caught on average once every 51 days. Falcons caught 26 gulls and 92 corvids during summer and autumn trials compared with 5 gulls and 10 corvids during winter and spring. Four corvids and the 4 other birds were caught beyond the boundary of the landfill site. All other captures were made within the landfill boundary (Table 1).

Falcons reduced the numbers of target species in all cases. Large reductions of black-headed gulls (range 39.8–98.4%) occurred at all sites in all seasons. Similar reductions occurred for lesser black-backed gulls (range 57.8–98.4%) at all sites although results were inconclusive due to posttreatment seasonal changes during summer and autumn. Large reductions in the numbers of herring gulls (30.2% and 97.9%) were achieved in autumn and winter and in summer and autumn for corvids (47.2% and 55.6%). The only confirmed failure with falcons was against herring gulls in spring.

We conducted an average of 6.4 hawk flights per day throughout the study period. Length of flight varied between 20 seconds and 11 minutes. Mean time a bird was in the air was 1.2 minutes. Birds would either return to the fist or sit on a perch overlooking the site. Birds would be recalled from their perch after 1 hour or walked around the site on the falconer's fist for an equivalent time. Hawks left the landfill and needed to be retrieved once every 2.4 days. Retrieval time took an average of 53 minutes. In 2 of the 4 trial sites, birds were replaced after learning to forage on the waste. Hawks were not flown for an average of once every 7.6 days due to inclement rain or windy weather. Hawks could not be trained to swoop to a lure.

The hawks caught 46 corvids, for an average capture rate of 1 every 4.5 days. They caught 12 gulls, for an average of 1 every 16.7 days. Other species, including rats ($n = 22$), rabbits ($n = 20$), squirrels ($n = 11$), and other birds ($n = 11$, including 8 nestling corvids), had an average capture rate of 1 every 3.7 days. Hawks caught 10 gulls and 39 corvids during summer and autumn trials compared with 2 gulls and 7 corvids during winter and spring. All gulls, rats, and 36 of the corvids were captured within the boundary of the landfill site. Others were caught in surrounding fields or woodland (Table 2).

Hawks reduced the numbers of target species on 9 occasions. On 4 of these occasions, however, the population continued to fall after treatment ended. Successful reductions were achieved on single occasions for black-headed gulls in summer (64.7%), herring gulls in spring (92.1%), and corvids in winter (37.1%), with possible success in one other category against lesser black-backed gulls in summer.

Hawks achieved 3 successful or probably successful reductions with 8 failures. Falcons achieved 13 successful or probably successful cases and only 1 failure. Hawks were successful or probably successful in 2 of the 4 species

Table 2. Mean changes in gull and corvid numbers at 4 landfill sites treated with hawks in the United Kingdom in 2000.

Site[a]	Species[b]	Pretreatment population	SE mean	Treatment population	SE mean	Posttreatment population	SE mean	% change during treatment[c]	$P \leq$	Success[d]	n[e]
1	bhg	199.56	29.74	70.51	7.99	211.20	23.66	64.67	0.001	1	88
1	lbb	13.55	1.75	9.06	1.30	119.63	21.22	33.15	0.312	2	71
1	hg	15.18	3.93	0.90	0.26	0.71	0.20	94.06	0.001	4	87
1	cor	192.21	15.09	223.52	19.17	388.16	28.59	+16.29	0.001	3	182
2	bhg	621.39	98.68	388.64	67.17	0.76	0.30	37.46	0.039	4	88
2	lbb	19.00	2.98	57.27	8.03	953.02	158.69	+201.4	0.032	3	71
2	hg	552.11	106.27	43.65	6.98	223.68	34.61	92.09	0.001	1	87
2	cor	230.07	19.65	279.42	16.56	378.71	23.48	+21.45	0.001	3	182
3	bhg	53.75	9.29	347.54	21.70	968.00	97.75	+546.6	0.001	3	88
3	lbb	15.83	3.40	62.84	3.87	72.72	8.25	+296.9	0.001	3	71
3	hg	11.94	3.69	103.72	11.71	718.24	82.37	+768.4	0.001	3	87
3	cor	148.71	15.83	93.56	10.24	178.56	25.62	37.08	0.002	1	182
4	bhg	256.47	31.27	754.44	66.24	1,807.18	196.70	+194.8	0.001	3	88
4	lbb	3.944	0.35	3.52	0.45	1.50	0.32	10.71	0.17	3	71
4	hg	2,080.82	176.76	3,278.11	204.75	3,898.57	355.72	+57.54	0.001	3	87
4	cor	1,056.50	59.99	503.27	32.08	489.00	42.71	52.36	0.001	4	182

[a] Site 1: summer 2000, West Yorkshire; Site 2: spring 2000, Manchester; Site 3: autumn 2000, Merseyside; Site 4: spring 2000, Devon.
[b] bhg = *Larus ridibundus*, cor = Corvidae, hg = *L. argentatus*, lbb = *L. fuscus*.
[c] Percentage change (negative unless otherwise stated) in population from pretreatment population.
[d] 1 = success: significant reduction between pretreatment and treatment period with posttreatment stability or increase. 2 = probable success: no significant reduction during treatment but posttreatment increase. 3 = failure: increase during treatment, or no change in population between pretreatment, treatment, and posttreatment periods. 4 = unknown: reductions during treatment followed by continued posttreatment reductions.
[e] Number of hours of observation during treatment.

classifications in summer and 1 of the species classifications in winter. Falcons were successful or probably successful against 3 of the 4 species classifications in all seasons.

Discussion

In our study falcons were more effective than hawks at deterring gulls and corvids from landfill sites. Falcons were completely effective against black-headed gulls, and completely or probably effective against corvids in all cases. These birds are smaller than the other target species and, therefore, require less foraging time on a landfill site to gain sufficient resources to survive. They also are more agile than the larger gulls.

Based on our work, it would not be practicable for deterrence staff to maintain a continuous presence of raptors on-site. Short-term breaks occurred when staff stopped to eat or drink, change birds over, lost birds off-site, or did not fly birds because of inclement weather conditions. It would, therefore, be expected that the smaller corvids and black-headed gulls, which require less foraging time, would be able to exploit the opportunities these intermittent but regular breaks in deterrence permitted. The effectiveness of falcons against these species, however, suggests that this was not the case.

Peregrine falcons in the United Kingdom are natural predators of corvids and black-headed gulls (Cramp and Simmons 1980). Use of trained peregrines or their hybrids, whether hunting, being flown to simulate hunting, or more importantly, perceived as potentially present, was sufficient to deter these species. Falcons were, however, less effective against larger gull species. These are rarely a natural target of wild peregrines in the United Kingdom. During spring trained falcons failed to deter herring gulls from the study site.

Our results were also inconclusive for the similarly sized lesser black-backed gull during summer and autumn. In contrast, hawks were only effective against black-headed gulls during summer, herring gulls in spring, and probably lesser black-backed gulls in the summer. Data were inconclusive against gulls on 3 other occasions. The success ratio of falcons to hawks when compared against gulls was 4:1.

Gulls frequently responded to hawks by ignoring them. Occasionally this would result in an opportunity for a hawk to surprise and therefore capture a gull. More often, however, gulls would feed or loaf on-site when a hawk was present on a perch but remain wary of any movement. We also noted that if a hawk captured a corvid, gulls would appear to use this as a signal to begin foraging. A hunting bird that has prey was, thus, being perceived to no longer remain a threat. As broad-winged species in the United Kingdom do occasionally target corvids, we anticipated that their effect on corvid numbers would be more successful. We only observed one successful case, however, suggesting that corvids were able to habituate to their presence and continue using landfill sites when hawks were the deterrent method.

Behavioral ecology of each raptor group may explain some of the differences between the successes of falcons as opposed to hawks. Hawks fly more slowly than falcons (Cramp and Simmons 1980). Given the open aspect of landfill sites, any target species that did feel threatened by an approaching hawk appeared to have been able to avoid capture by outpacing it. Discussion with falconry staff

suggested that target species could only be caught by hawks when they were able to ambush them. This would occur either by the hawk remaining hidden on a perch close to the tipping area, through release after stalking by the falconer, or through flights behind soil bunds or other points that obscured the bird's approach. During the early part of each trial, birds also frequently failed to respond to the approach of a hawk. This contrasted with the use of falcons. Falconers reported that target species were taken regardless of where the falcons were released. Falcons made virtually all their prey captures either on or over the site, and were able to overtake and capture prey from most distances. The presence of a falcon in the sky, however, would put all target birds immediately into the air or heading into woodland. Corvids appeared to attempt escape by heading into woodland. Gulls were unable to locate environments that would provide a similar level of security to that which corvids experienced when using woodland. No water bodies, for example, were present within 5 km of any of the study sites; hence, gulls were forced to flee any falcons to be sure of survival. Gulls may, therefore, have been more wary of visiting locations at which a potentially lethally hunting bird was present. This could explain the greater overall effectiveness against gulls by falcons compared with hawks. Gulls would attempt to escape by remaining above the falcon or by departing the site as rapidly as possible. While target species were observed attempting to forage when hawks had caught a bird on-site, the use of falcons that did not hunt, but were perceived to be hunting may have been the key to more effective deterrence. The natural hunting and response instincts of predator and prey in these circumstances thus suggest that falcons provide a better deterrence tool than hawks.

Daily Population Fluctuations

During periods of pre- and posttreatment when scavenging birds were left to feed undisturbed, gulls were the most abundant species at the operational landfill during daylight hours. Corvids fed more frequently during the early mornings and late evenings. A successful reduction in gull numbers on-site during the operational day may have led to increased opportunities for corvids. This correlates well with observations made during other studies that use integrated deterrence techniques during a site's normal operating hours only (Baxter 2005). Care would, therefore, need to be taken to ensure that all scavenging species were routinely targeted. Concentrating purely on the most abundant species present could result in associated increases in other species. Daily population changes also were influenced by the availability of alternative foraging resources. Ploughed fields for example may act as a powerful, but temporary, attraction to scavenging species (Duhem et al. 2003). This could influence the ease with which birds can be deterred from a site. On occasions during autumn, hawks and falcons were flown when few target species visited the site. Conversely, corvids are classified as a pest and frequently are shot in agricultural areas. A landfill site may, therefore, appear a safe haven from agricultural control measures. Despite these varying attractions and deterrents, falcons were consistently more successful at reducing target species numbers than hawks.

Seasonality

Our results are based on reductions achieved between pretreatment monitoring and treatment monitoring. It is clear, however, that the migration of target species away from an area needs to be considered before any observed reductions can be attributed to program implementation. Postcontrol numbers also could be influenced by a residual effect of the treatment period. Thus, differentiating between migration and residual effects is problematic. In the United Kingdom it would be expected that black-headed gull and herring gull populations would decline between March and May, remain stable between May and August, increase from August to November, and remain stable between November and March. Lesser black-backed gulls would increase in spring and decrease in autumn, and corvids would remain relatively stable throughout the year.

Severe cold weather on the European continent also can result in additional increases in United Kingdom wintering gull populations, particularly during January. The use of postcontrol data can only, therefore, be used to assist with determining whether responses could be explained by natural population fluctuations. During the spring and autumn migratory periods, all gull populations observed during posttreatment hawk monitoring exhibited expected changes in relation to migratory strategies. Following spring falconry studies, lesser black-backed and herring gull numbers went in opposition to expected migratory patterns. This could be due, therefore, to delayed migratory movements or residual treatment effects in relation to lesser black-backed gulls, or to the presence of localized breeding colonies in relation to herring gulls. Residual treatment effects would only occur if the treatment was effective.

Weather Conditions

Weather conditions were variable but similar across all sites. Falconers determined when to fly their raptors. Hawks and falcons were not flown in wet weather because it caused water-logging of feathers. Strong winds, particularly when flying hawks, resulted in birds proving difficult to control. For fully effective deterrence, therefore, alternative techniques are needed to cover the periods when weather conditions prevent raptors being used. When wind speed increased, hawk use was discontinued prior to falcons. Experience of falconers resulted in an unwillingness to risk releasing a broad-winged bird in strong winds. The pest control company undertaking the flying of birds reported that hawks had been lost in strong winds and not recovered. They also were willing to fly falcons in stronger winds since they appeared to be able to hunt more effectively and, therefore, provided the falconers with a greater level of enjoyment. This proved to be a key factor in the use of falconry for deterring scavenging birds from landfill sites.

Staff proved highly motivated during all raptor-flying trials. It was apparent that the capture of birds provided a

heightened level of job satisfaction, resulting in a committed work ethic. The risk that falconers would allow small numbers of birds access to the site to gain an exciting flight was offset by their professional aim of preventing any birds landing on-site. An additional reason for the better performance of falcons may, therefore, have been that staff perceived the opportunity of a successful hunt and were thus prepared to ensure the birds were deployed at the most appropriate times.

Capture Rates

Despite the higher capture rate, two-thirds of all falcon flights did not involve attempts to capture target species. Flights that involved the simulation of a hunting bird by stooping toward a target (lure), or that involved circuits of the site and return to the handler, prevented hunting. Only one-third of falcon flights could, therefore, have resulted in a target bird being caught. Capture rate per hunting bird was, therefore, 3 times higher than that reported for falcons. Hawks were not flown to a lure. Their natural hunting instincts prevented them from being trained in this way. Forays most frequently involved flying birds between a falconer's glove and a suitable perch on the landfill site after which the hawk would hunt at its discretion. Capture rates and the influence of perceived hunting (stooping to a lure) may be important factors affecting the level of deterrence that can be achieved. Time of year also appeared to affect the ability of falcons or hawks to capture scavenging birds. Both groups of predators showed a bias in the numbers of birds caught relating to season. Gulls and corvids were caught more frequently during summer and autumn. Bird control staff did not, however, accurately record the age of captured birds. Discussions revealed that "young" birds, which were more easily caught, provided ideal targets for enhancing the confidence of trained raptors. Future studies should record the age of any captured birds.

Lost Birds

Hunting birds occasionally departed the landfill to hunt independently off-site. This would result in the active area of the landfill being vacated by the falconer while retrieval was undertaken. When a hunting falcon failed to capture a target species on-site and set off in chase of a bird off-site, it would frequently fly several miles before finding a suitable perch. While the frequency of departures was therefore limited, the time taken to retrieve a falcon was significantly longer than that taken to retrieve a hawk. Hawks proved more likely to depart a site since all birds had the potential to hunt and were less effective at capturing species on-site. They generally did not fly significant distances, however, and often would capture prey in woodland adjacent to a site or sit on a suitable perching area in a surrounding field. Their more rapid retrieval compared with falcons related to the distance they flew when leaving the site.

Site management procedures also may influence the effectiveness of both groups of species. The amount of waste deposited was consistent both between sites and days. Personnel remained the same at each site throughout the studies; hence, any variability between the successes of hawks or falcons at individual sites could not have been caused by changes in staff. Training and regular auditing of staff at all sites was undertaken to maintain a standard working practice.

Management Recommendations

Neither hawks nor falcons were able to completely eliminate all scavenging birds from any of the landfill sites in this study. Thus, they should not be relied upon as a single technique where complete exclusion is required. Nevertheless, in our study falcons were more successful at reducing scavenging bird numbers than hawks. We recommend, therefore, that falcons are better suited than hawks for use within an integrated bird management program for landfill sites. However, the additional costs of using trained professional staff to deploy raptors as deterrents, in comparison to automated systems needs to be carefully weighed against the benefits of their effectiveness.

Acknowledgments

Viridor Waste Management, Caird Bardon, and Biffawaste provided support and sponsorship of these trials, through the commitment of their landfill facilities and environmental bodies. Funding was facilitated by Entrust, as part of the United Kingdom landfill tax credit scheme, and P. Drobig of the North West Environmental Trust. Particular thanks are due to the various site managers and staff at each site who had to put up with long periods during which scavenging birds were allowed access to their sites. N. Dixon, T. Drew, P. Mountain, A. Robinson, and K. White of the Central Science Laboratory collected the majority of ornithological data. J. Dickson, from the company Natural Bird Control, provided staff to implement the bird deterrence measures at each site and valuable references on falconry. Thanks also go to G. Smith of the Central Science Laboratory for providing much appreciated and constructive comments of an earlier draft.

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Associate Editor: Euler.