

EFFECTIVENESS OF AN OVERHEAD WIRE BARRIER IN DETERRING GULLS FROM FEEDING  
AT A SANITARY LANDFILL

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ABSTRACT

On behalf of Browning-Ferris Industries (BFI), we assessed the effectiveness of fine parallel overhead wires in deterring herring and ring-billed gulls from landing at an active sanitary landfill in Niagara Falls, N.Y. BFI was responsible for design and installation of the wire system; LGL Ltd. was responsible for the study of wire effectiveness from January to December 1983. The study design consisted of alternating periods with and without wires over the active portion of the test landfill, plus control observations at two other landfills.

Overhead wires at 12 m (40 ft) spacing deterred most herring gulls from feeding. Ring-billed gulls were largely deterred by wires at 12 m spacing when limited garbage was present, but penetrated wires at 12 m spacing when attracted by large amounts of garbage. Wires at 6 m (20 ft) spacing deterred most ring-billed gulls in late spring even with large amounts of garbage present. In summer, when peak numbers of gulls visit landfill sites in the area, numbers of feeding ring-billed gulls were substantially reduced by wires 6 m apart, but the deterrent effect was less marked than at other seasons. A large proportion of gulls feeding under the wires in summer were young-of-the-year.

INTRODUCTION

Many species of gulls are opportunistic feeders and most sanitary landfills attract gulls at one time or another. At sites receiving large quantities of household refuse, it is usually impossible to cover the refuse quickly enough to prevent gulls from feeding.

Exclusion of gulls from sanitary landfills is desirable for a number of reasons. Gulls often carry refuse away and deposit uneaten items elsewhere, creating both a nuisance and a potential health hazard. When a landfill is near an airport, gulls feeding at the landfill can be a significant hazard to aircraft (Blokpoel 1976). In the Great Lakes area, the explosive population growth of the ring-billed gull Larus delawarensis (Blokpoel 1983) with attendant nuisance and, in some areas, hazard to aircraft problems, has been attributed at least partly to the availability of man-made food.

Most attempts to deter gulls from feeding at sanitary landfills are only partially successful and the methods available are usually labor-intensive and expensive (e.g. scaring) or impractical (e.g. night dumping). The development of a cheap, effective method of deterrence would have wide applicability. Anecdotal evidence suggested that overhead wires could be such a method.

Overhead wires have been used at some fish hatcheries for many years to protect the fry (McAtee and Piper 1936) but only within the last few years have wires been used in other areas. Widely-spaced wires have been used to exclude gulls from reservoirs in California (Amling 1980) and two urban parks in Toronto, Ontario (Blokpoel and Tessier 1984). Unpublished accounts suggest that wires have successfully excluded gulls from sanitary landfill sites in California (Ichikawa 1981; Wyeth 1982). However, the attraction of gulls to the California site visited by Wyeth may have been low since it was 31 km inland. Numbers of gulls present before and after wires were installed are not known for either California site. Wire spacing over the reservoirs, parks and landfills ranged from 2.5 m to 35 m. Thus, the wires apparently constitute a 'psychological' rather than a physical barrier to gulls.

The present study was designed to determine, over a 1 yr period, the effectiveness of overhead wires at an active sanitary landfill site about 2.5 km from both the Niagara Falls International Airport and the Niagara River, a noted concentration area for gulls. We used an experimental approach to determine an appropriate configuration for the wires and to measure the effectiveness of the wire barrier. This was the first systematic test of wire effectiveness as a deterrent to gulls at an active sanitary landfill.

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#### METHODS

The study was conducted from 29 Dec 1982 to 30 Dec 1983 at BFI's Pine Avenue site in Niagara Falls, N.Y. Gulls are present year round in the Niagara region. On the BFI site, herring gulls (Larus argentatus) predominated in the periods 29 Dec 1982 to 25 Jan 1983 and 22 Oct to 30 Dec 1983. Ring-billed gulls predominated from 20 Feb to 21 Oct 1983. No gulls were on the BFI site from late January to late February, although some gulls were in the area throughout the winter.

The experimental design involved counting gulls during several alternating periods with the wires in place followed by periods with no wires, along with simultaneous counts at control landfills without wires. Each replicate was intended to include one week without wires followed by three weeks with wires. If the wires are effective, gull numbers should decrease each time the wires are installed and increase each time they are removed. In addition to this series of wires up/wires down cycles, the wires were to be in place for a final period of several months to assess whether habituation occurred. The actual procedure varied somewhat from this design because of logistical factors. The wires were in place for four periods varying in length from three weeks to 4.5 months; periods without wires varied from two weeks to one month (see Tables 1 and 3).

Wires covered only the active sanitary landfill (hereafter ASL), a trapezoidal area measuring approximately 300 m by 150-180 m. Areas adjacent to the ASL are part of the BFI site but received no putrescible waste and

were not covered by wires. The wires were 0.8 mm (0.032 in) in diameter and spanned the 300 m dimension of the ASL. Monofilament was used initially but was replaced by wire because of frequent breakage. Each wire was supported about 10 m above the ASL by two metal poles. The poles were telescopic to allow increased height as the level of the ASL rose.

Nominal spacing between adjacent wires was originally 12 m (40 ft) but this was reduced to 6 m (20 ft) for the third and fourth periods with the wires in place because of the ease with which ring-billed gulls were able to penetrate the 12 m spaces. Actual spacing between adjacent wires approximated the 12 or 6 m nominal spacing in most cases. However, problems with pole placement resulted in spaces wider than 12 m over the east side of the ASL during the second period with the wires in place. A storm in late October felled several poles, with the result that all spaces were 12 m or more for the last six weeks of the fourth period. In addition to the parallel overhead wires, we used various arrangements of horizontal wire or monofilament at lower levels around the perimeter of the ASL. These wires were attached between adjacent poles in attempts to prevent gulls from reaching the ASL by flying between poles below the level of the overhead wires.

Gulls on the ASL and adjacent loafing areas were counted several times per day on seven days per week from 29 Dec 1982 to 15 Mar 1983 and on three to six days per week from 15 Mar to 30 Dec 1983. Gulls circling overhead were also counted. In addition, we counted gulls at two control landfills (North Tonawanda and Modern Disposal), both located within 15 km of the BFI site, twice per week between the hours of 1030 and 1530 EST.

In the presentation of the results, we use four daily counts from the BFI site. These counts are (1) the daily maximum on the whole BFI site, (2) the daily maximum on the ASL, (3) the midday (1030-1530 EST) count on the whole BFI site and (4) the midday count on the ASL. The midday counts are used for comparison with counts at control sites. Statistical comparisons were made with the Mann-Whitney U-test.

One factor that affects numbers of gulls on a landfill site is the amount of edible refuse present. Most household refuse in the Niagara area is burned at an Energy From Waste (EFW) plant. When the plant is operating, very little edible refuse is brought to either our experimental site or the North Tonawanda site. This was the case from 27 Dec to 17 Mar and again from 11 Oct to 30 Dec. During these two periods we arranged to have about 20 T of household garbage per day diverted from the EFW plant to the BFI site to provide at least a minimum amount of edible waste. From 18 March to 11 October, the EFW plant operated at capacity only intermittently, and large quantities of edible refuse were available regularly at both the BFI site and the North Tonawanda control site.

The second control site (Modern Disposal) was not licensed to receive putrescible waste and we have no definite information about what was dumped there. However, our observations of gulls on this site suggest that edible material was often present.

## RESULTS AND DISCUSSION

### Ring-billed Gull

The ring-billed gull was the dominant species (>90%) of gull on the BFI site from 22 Feb to 21 Oct 1983. During this period the wires were in place three times: 1 Mar-1 Apr, 16 Apr-24 June and 25 July-21 Oct. From 1 Mar to 1 Apr, spacing between wires was 12 m. The wires were reinstalled at 12 m spacing on 16 Apr and spacing was reduced to 6 m between 16 and 22 Apr. Spacing then remained at 6 m until 24 June. Spacing was also 6 m from 25 July to 24 Oct.

**Number of Gulls on the Site.** -- Migrating ring-billed gulls arrived in the Niagara Falls area in late February when the wires were absent. Numbers of gulls on the BFI site rapidly increased from zero to a maximum of 650 on 25 February. The mean daily maxima during the last week of February were 338.6 gulls on the site and 297.1 gulls on the ASL (active sanitary landfill; Table 1). During the first half of March, with wires in place at 12 m spacing, the mean daily maxima were 61.3 and 15.8 gulls, respectively (Table 1). The reduction was attributable to the wires, since numbers at both control sites increased from late February to early March (Fig. 1).

On 17 Mar the EFW plant ceased operation and large quantities of edible refuse began arriving at the BFI site and the North Tonawanda control site daily. Presumably in response to the much larger amount of edible refuse present, gull numbers at the BFI site increased in late March (mean daily maxima of 103.6 on the ASL and 276.2 on the whole site). However, the wires were apparently still having an effect, since numbers at the North Tonawanda control site increased to a much greater extent (Fig. 1).

Wires were absent during early April and were reinstalled at 12 m spacing on 16 Apr. Spacing was reduced to 6 m by addition of new poles and wires between 16 and 22 Apr. While the wires were absent, the maximum daily counts were over 300 gulls on the whole BFI site and over 150 gulls on the ASL. Numbers decreased when wires were reinstalled at 12 m spacing but the reduction was much greater after 6 m spacing was achieved. From late April through June with wires at 6 m spacing, the mean daily maximum was 71.6 on the whole site and 25.6 on the ASL. These numbers were lower than numbers at control sites, particularly North Tonawanda (Fig. 1).

The wires were again removed at the BFI site on 24 June. Numbers on both the site and the ASL increased dramatically (Table 1). Numbers on both control sites also increased in early July but to a much lesser extent than numbers at the BFI site (Fig. 1). This increased use of landfill sites in July was expected based on an earlier study (LGL Ltd. 1974). However, the greater increase at the BFI site when the wires were removed is noteworthy. Ring-billed gulls hatched in 1983 did not contribute substantially to the initial increase in numbers at the BFI site after the wires were removed. Only seven young-of-the-year were identified on the site up to 7 July. Hatch at the Niagara River colonies began about 17 May (pers. obs.) and the peak of fledging probably occurred about 1 July.

On 8-24 July, in the absence of wires, the mean daily maxima were 3607.1 gulls on the whole BFI site and 800.0 on the ASL. From 25 July to 4 Sep, the wires were in place at 6 m spacing, and numbers declined by 33% and 68%,

TABLE 1

Numbers of ring-billed gulls on the BFI site during periods with and without wires. Based on daily maximum counts.

Date	No. of gulls	
	Active landfill	Whole site
No wires		
22-28 Feb	297.1	338.6
Wires up--12 m		
1-17 Mar	15.8	61.3
18 Mar-1 Apr <sup>1</sup>	103.6	276.2
No wires		
2-15 Apr	222.7	395.8
Wires up		
16-22 Apr--12 m	92.0	183.4
23 Apr-24 Jun--6 m	25.6	71.6
No wires		
25 Jun-7 Jul	432.5	1389.3
8-24 Jul	800.0	3607.1
Wires up--6 m		
25 Jul-4 Sep	254.8	2433.1
5 Sep-21 Oct	116.3	712.8

<sup>1</sup> Large volumes of household refuse came to the site daily after 17 March. Prior to 17 March only small amounts of edible refuse arrived each day.

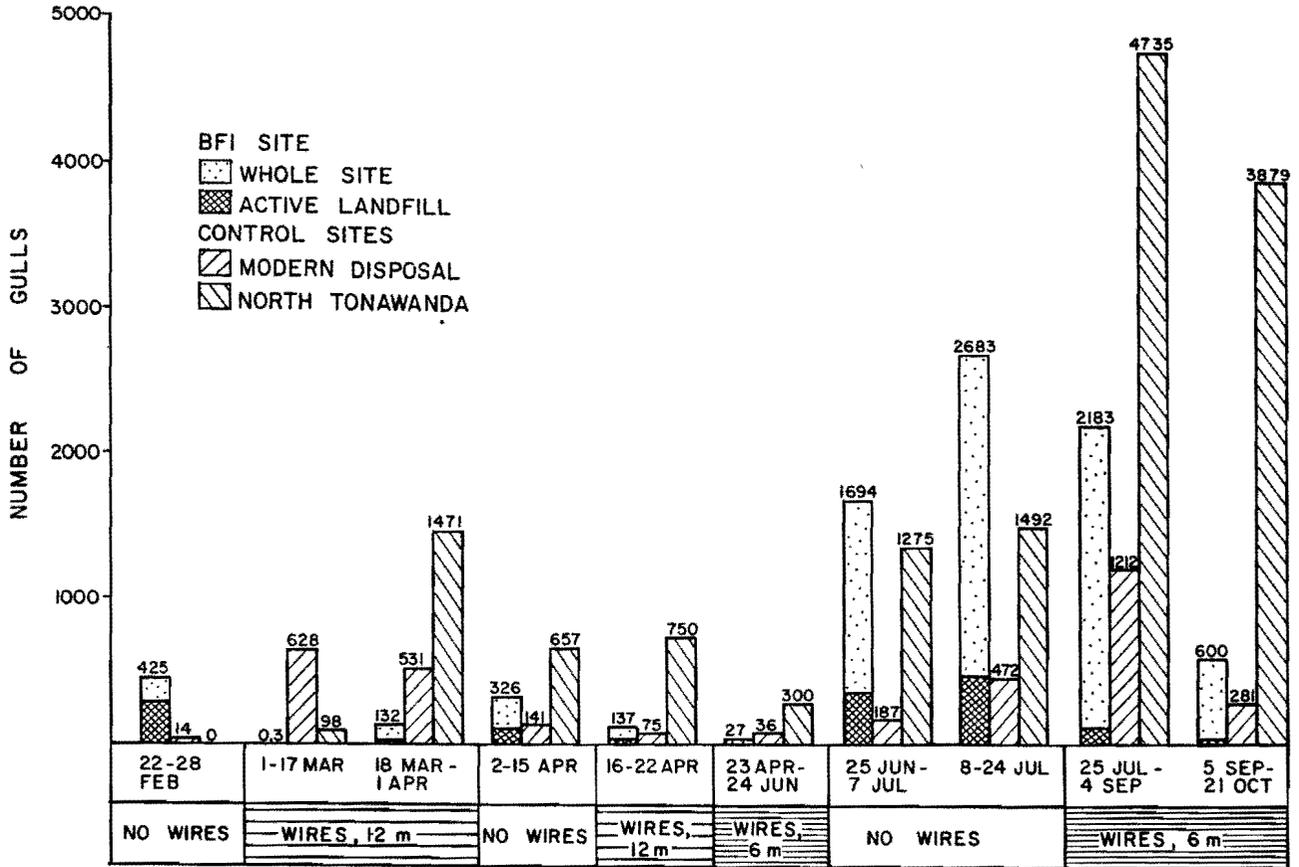
respectively, to 2433.1 and 254.8. In contrast, numbers at both control sites increased by a factor of three over the same period (Fig. 1). Through September and October, numbers of gulls at both the BFI site and control sites decreased as ring-billed gulls began migration south to wintering areas; numbers on the ASL were again low compared to numbers on the whole BFI site and on the control sites (Fig. 1).

Many of the gulls that penetrated the wires during the late summer period were young-of-the-year. We estimated that young gulls rarely comprised less than 20% and frequently comprised 50% or more of the individuals under the wires. Young gulls averaged only 9.8% of the gulls on the whole site in late summer.

**Test of Wire Effectiveness.** --To test whether the wires had a significant deterrent effect against ring-billed gulls, we used the Mann-Whitney U test to compare numbers of gulls on the BFI site during periods with and without wires. We used counts at control sites to standardize data from the BFI site for seasonal variation in gull numbers. The midday counts at the ASL and on the whole BFI site were divided by the midday count at a control site for that day. Ratios during a period with wires were then compared with ratios during adjacent periods without wires (Table 2). Days when there were gulls at neither the BFI site nor the

FIGURE 1.

Numbers of ring-billed gulls at the BFI site compared to numbers at two control sites for periods with and without wires. Bars for the BFI site are based on counts made near midday on days when counts were made at control sites.



respective control site were excluded. When the denominator was zero, i.e. no gulls at the control site but gulls at the BFI site, we treated the ratio as larger than any calculated value. These cases were all treated as ties in the ranking procedure for the Mann-Whitney U test.

Substantial numbers of ring-billed gulls came to the BFI site as a whole when wires were in place at 12 m spacing in March, especially during the second half of the month (mean midday count of 132.0 gulls, Fig. 1). Nevertheless, gull numbers at both control sites were much larger. The standardized numbers of gulls at the BFI site were much smaller during March than during the adjacent periods without wires. For example, the BFI/Modern Disposal ratio for the whole site was 2.65 without wires but only 0.24 while the wires were in place. Similarly, the BFI/North Tonawanda ratio for the whole site was 0.61 without wires but 0.13 with wires. Regardless of which control site was used to standardize the data, gull numbers on both the active landfill and the whole BFI site were significantly lower when the wires were in place at 12 m spacing during March than when wires were absent during adjacent periods (Table 2).

TABLE 2

Statistical comparisons of numbers of gulls during periods with and without wires. Counts were standardized for seasonal effects by dividing counts at the BFI site by the count at a control landfill (North Tonawanda or Modern Disposal) on the same date.

	12 m spacing R-b. gull dominant <sup>1</sup>		6 m spacing R-b. gull dominant <sup>2</sup>		12 m Spacing Her. gull dominant <sup>3</sup>	
	Whole site	Active landfill	Whole site	Active landfill	Whole site	Active landfill
BFI/Modern Disposal						
Ratio with wires	0.24	0.05	1.84	0.08	0.60	<0.01
Ratio without wires	2.65	1.37	5.83	1.23	3.78	2.17
N <sub>1</sub> , N <sub>2</sub> <sup>4</sup>	12,5	11,5	42,12	32,11	10,4	10,3
Mann-Whitney U	1	6.5	182.5	12.5	3	6.5
Probability level	<0.002	<0.02	NS	<<0.001	0.02	NS
BFI/North Tonawanda						
Ratio with wires	0.13	0.02	0.31	0.01	0.07	<0.01
Ratio without wires	0.61	0.32	1.36	0.29	0.79	1.56
N <sub>1</sub> , N <sub>2</sub>	12,5	10,5	47,12	47,12	15,8	15,6
Mann-Whitney U	2	6	60	39	16.5	16
Probability level	<0.002	0.02	<<0.001	<<0.001	<0.02	<0.02

<sup>1</sup> The period with wires (1 Mar-1 Apr 1983) was compared to periods lacking wires (22-28 Feb 1983, 2-15 Apr 1983).

<sup>2</sup> Periods with wires (23 Apr-24 June 1983, 25 July-21 Oct 1983) were compared to periods lacking wires (2-15 Apr 1983, 25 June-24 July 1983).

<sup>3</sup> Periods with wires (18 Jan-6 Feb 1983, 28 Oct-15 Dec 1983) were compared to periods lacking wires (9-17 Jan 1983, 7-18 Feb 1983, 16-30 Dec 1983 for North Tonawanda; 9-17 Jan 1983, 7-18 Feb 1983 for Modern Disposal).

<sup>4</sup> N<sub>1</sub> represents counts with the wires in place; N<sub>2</sub> counts without wires.

The two periods with wires at 6 m spacing were analyzed together. There was a highly significant difference in gull numbers on the whole BFI site for periods with versus without wires when counts at North Tonawanda were used as the basis for standardization. The difference was not significant when counts at Modern Disposal were used as the basis for standardization, largely because gulls used Modern Disposal only intermittently during May and June. Regardless of which control site was used as the basis of standardization, gull numbers on the ASL at the BFI site were significantly lower during periods with wires in place at 6 m spacing ( $P < < 0.001$ ; Table 2).

**Behavior and Habituation.** -- Gulls often become habituated to active deterrent techniques such as scaring. Some habituation apparently did occur when the wires were spaced at 12 m in March. Ring-billed gulls appeared to learn that they could penetrate 12 m spaces without danger. Numbers on the ASL increased and gulls spent a larger proportion of the day loafing on areas adjacent to the ASL toward the end of March.

However, gulls apparently did not become accustomed to wires at 6 m spacing. Although fairly large numbers of gulls did penetrate the barrier in summer, the wires affected both the hourly pattern of use of the ASL and the

behavior of the gulls while on the ASL. When wires were absent, at least a few gulls fed and many gulls loafed on the ASL at most times of day. With wires in place, gulls did not loaf on the ASL itself but arrived from adjacent loafing areas to feed three or four times per day. In the absence of wires during July, gulls began to feed in early morning. Wires were reinstalled on 25 July. Through August and September, feeding tended to begin progressively later in the day.

Besides changing their feeding pattern, ring-billed gulls also responded differently to vehicles after the wires had been in place for some time. In the absence of wires, only gulls directly in the path of a vehicle usually flushed and these birds merely flew a few metres to the side and landed again. When wires were overhead, a vehicle moving through a group of gulls caused the whole group to flush and usually to leave the ASL at least temporarily. When more than one group of gulls was on the ASL, the flushing of one group often resulted in the flushing of all groups. This response became more consistent in late August and September when the wires had been in place for several weeks.

Since use of the wire barrier was intended to reduce the gull hazard to aircraft using the Niagara Falls airport, we also counted gulls circling over the BFI site. Gulls attempting to reach the ASL through the wires sometimes circled just above wire level but these birds rarely spiralled upwards. We saw gulls at altitudes greater than 160 m above ground much more frequently when wires were absent than when they were present and we saw gulls above 300 m only when wires were absent.

Although no individual gulls were marked, the pattern of feeding in only 3-4 bouts per day suggests that some gulls on the site in late summer loafed but did not feed there. On most days in August and September, the maximum number of gulls on the ASL during a feeding bout was 300 or less. During a feeding bout there was little interchange of gulls between the ASL and surrounding loafing areas. Even if each gull fed during only one feeding bout per day, only about 1200 gulls could have fed at the ASL on one day. On most days in August, over 2000 gulls loafed on the site (Table 1). Moreover, the estimate of 1200 gulls obtaining food on the ASL each day is probably excessive. During most feeding bouts 25-50% of the gulls under the wires were young-of-the-year, even though the average number of young on the site each day was only about 200 during late summer. Thus, young gulls seemed more persistent and perhaps more successful than adults in their attempts to penetrate the wire barrier.

The young of many species of gulls are less efficient and less successful than adults in obtaining food (e.g., Verbeek 1977; Searcy 1978). The fact that we observed young ring-billed gulls to be proportionately more successful than older gulls in penetrating the wire barrier suggests that penetration of the barrier is not primarily a learned skill. Rather, older gulls probably have learned to be wary of unusual situations such as the unexpected appearance of a fine wire as they descend to feed. In addition, the food requirements of young gulls and, therefore, their motivation for penetrating the wires, are likely higher than those of adults. Whether gulls that first encounter the wires as fledglings will penetrate the barrier as adults remains unknown.

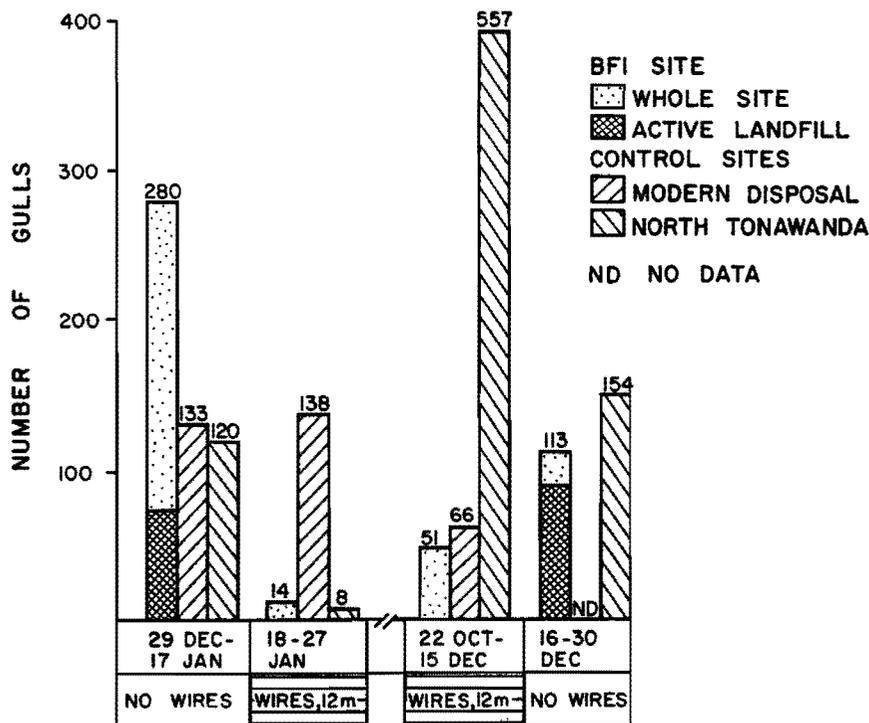
## Herring Gull

Herring gulls predominated on the BFI site during two periods--29 Dec 1982 to 25 Jan 1983 and 22 Oct to 30 Dec 1983. These periods encompassed the control period before the wires were installed for the first time (29 Dec 1982-17 Jan 1983), the first period with wires (18 Jan-6 Feb 1983), a 7-wk period with wires in late fall (22 Oct-15 Dec 1983), and a final 2-wk period with no wires (16-30 Dec 1983). Except for the last week of October, wires were at 12 m spacing when herring gulls predominated.

After wires were installed on 18 January, the average daily maximum number of gulls on the whole BFI site and especially the active sanitary landfill (ASL) decreased substantially (Fig. 2, Table 3). Within a few days, gulls stopped coming to the BFI site altogether. Gulls also stopped visiting the North Tonawanda control landfill about this time, but they continued to go to the Modern Disposal control site for a further two weeks. Herring gulls that did come to the BFI site during the first few days after the wires were installed seemed unwilling to penetrate the wires. The maximum seen on the ASL was 25 and these gulls remained under the wires for only about 2 min.

FIGURE 2

Numbers of herring gulls at the BFI site compared to numbers at two control sites for periods with and without wires. Bars for the BFI site are based on counts made near midday on days when counts were made at control sites.



Herring gulls again came to the BFI site in substantial numbers in late fall (Table 3). However, these birds rarely penetrated the wire barrier and the maximum seen on the ASL in late fall was 20 gulls. Gulls that loafed adjacent to the ASL sometimes flew low over the wires but made no concerted

TABLE 3

Number of herring gulls on the BFI site during periods with and without wires. Based on daily maximum counts.

Date	No. of Gulls	
	Active landfill	Whole site
No wires		
27 Dec - 17 Jan	150.3	198.4
Wires up		
18 - 27 Jan	6.1	60.4
28 Jan - 6 Feb	0.4	1.9
No wires		
7 - 21 Feb	0.7	1.1
Wires up		
22 Oct - 15 Dec	0.8	86.2
No wires		
16 - 30 Dec	135.7	140.5

effort to penetrate the barrier. After the wires were removed in mid December, numbers on both the site and the ASL increased (Table 3), while numbers decreased at North Tonawanda, the only control site receiving waste in late December (Fig. 2).

Numbers of herring gulls on the whole BFI site were significantly lower when wires were in place than in adjacent periods without wires regardless of which control site was used to standardize the data (Table 2). For the ASL, differences were significant when counts at the North Tonawanda control site were used to standardize the data, but not when counts at Modern Disposal were used. The latter result was attributable to low sample size for Modern Disposal rather than to any real lack of effectiveness of the wires; the BFI/Modern ratio as well as the BFI/Tonawanda ratio was much reduced during periods with wires (Table 2).

During both periods when herring gulls predominated on the BFI site, less than 25 T of edible refuse were dumped at the ASL each day. This refuse was quickly covered over. Although herring gulls will dig for food (Verbeek 1977), the BFI site was not very attractive to herring gulls. As a result, we have not shown conclusively that a wire barrier would effectively deter herring gulls when they were attracted by large amounts of food. Nevertheless, the amount of refuse going to the control sites was probably no greater than the amount going to the BFI site and the wire barrier was certainly successful in the circumstance we observed.

#### CONCLUSIONS

We found that fine parallel wires strung about 10 m above an active sanitary landfill will deter most gulls from landing on the active area. Numbers loafing nearby are also reduced, but to a lesser extent, and numbers

circling overhead are either reduced or unchanged. Success of the deterrent varied with species of gull, season, wire spacing, and the amount of edible refuse present. Herring gulls were very effectively deterred in fall and winter by wires spaced 12 m apart when only small amounts of edible refuse were present. We have no information about the reactions of herring gulls to wires when large amounts of edible refuse are present. Most ring-billed gulls were deterred by wires 12 m apart when little edible material was present, but 12 m spacing was less effective with much edible refuse. Wires at 6 m spacing effectively deterred most ring-billed gulls in spring, even with large amounts of refuse. In summer, numbers of gulls present on the active sanitary landfill when the wires were in place were substantial, but low relative to the very large numbers present without wires.

In general, widely spaced horizontal wires above the active portion of a sanitary landfill markedly reduced its attraction of gulls. It is especially significant that the wire system remained effective for many weeks without any use of supplementary scaring methods. A combination of wires plus other methods might be considered if wires alone were not a sufficient deterrent.

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