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# MONOFILAMENT LINES REPEL HOUSE SPARROWS FROM FEEDING SITES

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Widely-spaced lines or wires repel certain birds when stretched over sites needing protection (McAtee and Piper 1936). The technique has been used effectively to repel various avian species from sites such as reservoirs, public areas, and sanitary landfills (Amling 1980, Ostergaard 1981, Blokpoel and Tessier 1984, Dolbeer et al. 1988). However, there is still only limited information, some of it conflicting, regarding species repelled and installation procedures or circumstances that contribute to effective repellency (Pochop et al. 1990). Recently, Knight (1988) reported that monofilament lines spaced 30 cm apart protected grapes

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and various other horticultural crops in New Mexico from damage by house sparrows (*Passer domesticus*) and other birds (J. E. Knight, New Mexico State Univ., Las Cruces, pers. commun.). However, a subsequent experiment in Nebraska using monofilament lines (clear, 5.4-kg test, 30-cm spacing) failed to protect grapes from damage caused primarily by European starlings (*Sturnus vulgaris*) and American robins (*Turdus migratorius*) (Agüero 1990, Steinegger et al. 1991). Installation procedures were similar to those used by Knight (1988) but results differed, possibly because of the bird species involved, or because of line orientation (north–south) in the Nebraska experiment and resulting high visibility in relation to morning and evening sunlight reflections. If lines repel because birds cannot see them clearly enough to avoid them easily (Dolbeer et al. 1986, Knight 1988), then repellency might be reduced by bright sunlight reflections. We conducted 3 experiments to evaluate the repellency of monofilament lines to house sparrows at feeding sites. In the first experiment, we tested 2 line types (clear, lightweight and clear, moderate-weight) with 1 spacing (30 cm) and 2 orientations (north–south, east–west). A second experiment tested 2 line types (clear, moderate-weight and fluorescent yellow, heavier-weight) and 2 spacings (60 vs. 30 cm). A third experiment, which used the same treatments as experiment 2, examined house sparrow responses to lines during the nesting season using 2 populations, 1 previously exposed and the other not previously exposed to lines.

## METHODS

### *Experiment 1*

Experiment 1 was conducted from 31 December 1988 through 14 January 1989 in an open area on the University of Nebraska–Lincoln East Campus. Five feeding stations were constructed from wood, 60 × 60 cm square with a 4-cm-high outside edge. These stations were placed on the ground approximately 5 m apart in a line 15–18 m north of a barn. They were prebaited with finely cracked corn for at least 10 days to attract birds, establish a feeding pattern, and determine the amount of bait that would be consumed during 4 hours following sunrise. The experiment ran for 15 days. Before sunrise on each day, 50 g of corn was placed on each station, and uneaten corn was collected 4 hours after sunrise. One control station and 4 treatment stations were randomly established. For treatment stations, 4 dowels, 45 cm long by 0.5 cm diameter, were used as corner posts in a 120- × 120-cm square around each bait station. A single monofilament line connected the dowels and supported 3 supplemental cross-lines, installed with a 30-cm spacing, 17 cm above the food. The control had no dowels or lines. Then, using a 5 × 5 Latin square experimental design, treatments were rotated among the bait stations every 3 days (period) until each station had received each treatment. Period and station were blocking factors. The 4 treatments were CL (clear, lightweight: 1.8-kg test, 0.19 mm diam.) and CM (clear, moderate-weight: 5.4-kg test, 0.34 mm diam.) monofilament lines (Stren®, E. I. Du Pont De Nemours & Co., Wilmington, Del.), each with a north–south and an east–west orientation.

We observed bird use of feeding stations from a second floor window of the barn during 4 15-minute intervals selected randomly during the first 4 hours after sunrise. During observation intervals, instantaneous counts of birds on each bait station, including the outside edge, were recorded each minute, starting with 0 (16 counts per station per interval). Bird counts and bait consumption for each treatment were averaged for each of the 5 3-day periods. We analyzed bird counts and bait consumption using analysis of variance (ANOVA) on square roots to reduce heterogeneity of error variance (Snedecor and Cochran 1967). Specific comparisons made using orthogonal contrasts were treatments versus control, north–south versus east–west orientations, CL versus CM lines, and orientation by line type interaction.

### *Experiment 2*

Experiment 2 was conducted from 10 to 24 February 1989 using the same site and procedures as experiment 1, except that observation intervals were randomly selected within 3 hours after sunrise instead of 4, because bait on the control station in experiment 1 was consumed within approximately 3 hours on 9 of the 15 days. A control station had no lines or dowels. The remaining 4 stations had 1 or 3 supplemental cross-lines according to the chosen spacing, 30 or 60 cm, and 1 of 2 line types, CM or YH (fluorescent yellow [Stren®, Golden], heavier weight: 9-kg test, 0.46 mm diam.). Comparisons made using orthogonal contrasts were treatments versus control, 30 versus 60 cm spacing, CM versus YH line types, and spacing by line type interaction.

### *Experiment 3 (A and B)*

Experiment 3 was conducted from 31 May through 14 June 1989 at 2 locations. The first location (3A) was

Table 1. House sparrows counted and total bait consumption on stations protected by monofilament lines: effects of line type and orientation, Lincoln, Nebraska, 31 December 1988–14 January 1989.

| Treatment | | | |
|---|---|---|---|
| Line type[a,b] | Orientation | House sparrows counted ($\bar{x}$)[c] | Bait consumption (all species) ($\bar{x}$)[c] |
| CL | north–south | 0.2 | 30.6 |
| CL | east–west | 0.8 | 21.5 |
| CM | north–south | 0.0 | 20.5 |
| CM | east–west | 0.0 | 31.3 |
| Control | | 166.6*** | 117.1*** |

[a] CL = clear, lightweight (1.8-kg test, 0.19 mm diam.); CM = clear, moderate-weight (5.4-kg test, 0.34 mm diam).
[b] All lines were spaced 30 cm apart and stretched horizontally 17 cm above the food.
[c] Values given are means across 5 3-day periods.
*** Different from mean of treatments ($P < 0.001$).

the barn site where house sparrows had been exposed to lines for 48 days during experiments 1 and 2 and subsequent preliminary trials (22 Apr–9 May; Agüero 1990). During the latter portion of the preliminary trials, numbers of house sparrows observed under lines, although still low, were higher than had been observed in experiments 1 and 2. Thus, we looked at another location to gain insights about possible effects of house sparrow habituation to lines, and seasonal factors, which might include time budget constraints during nesting (Summers-Smith 1963) and the presence of juveniles (Blokpoel and Tessier 1984, McLaren et al. 1984). The second location (3B) was a University of Nebraska Agronomy farm site, located 6 km from the barn, where the house sparrow population had not been exposed to lines. At the Agronomy farm, birds were observed from a van positioned approximately 20 m from the row of 5 bait stations. Where possible, age and sex of birds were recorded. Methods, treatments, and data analysis were the same as in experiment 2. In addition, per-period proportions of house sparrows on control for experiments 1, 2, 3A, and 3B were compared using ANOVA and contrasts on rank transformations (Conover and Iman 1981). Contrasts were experiments 1 and 2 versus 3A and 3B, and experiment 3A versus 3B.

## RESULTS AND DISCUSSION

In all experiments, line treatments drastically reduced or eliminated house sparrow use of feeding sites. House sparrows counted at control versus treatment stations differed in all experiments ($P < 0.001$; Tables 1 and 2). Comparisons among line treatments showed no differences in house sparrow counts ($P \geq 0.608$), except in experiment 3A where CM line had fewer house sparrows counted than did YH ($P = 0.001$), and 30 cm spacing had lower counts than did 60 cm ($P = 0.049$).

House sparrows were the primary species at bait stations, accounting for 77% of the total in experiment 1, 95% in experiment 2, 96% in experiment 3A, and 100% in experiment 3B. European starlings accounted for the remainder in experiments 1 (23% of all bird counts) and 2 (5%), and common grackles (*Quiscalus quiscula*, 3%) and blue jays (*Cyanocitta cristata*, 1%) the remainder in experiment 3A. In experiments 1 and 2, use by European starlings was similar at control ($\bar{x}$ = 4.9 counted) and treatment ($\bar{x}$ = 6.4 counted) stations ($P \geq 0.86$). In experiment 3A, common grackles were counted at both control ($\bar{x}$ = 4.8 counted) and treatment ($\bar{x}$ = 0.8 counted) stations, and blue jays visited only 60-cm line stations ($\bar{x}$ = 0.7 counted). Except for European starlings, counts of these other species were too low to analyze.

Because other species were present, food consumption data do not accurately reflect house sparrow feeding patterns. Of all birds counted on stations with lines, starlings accounted for 98% in experiment 1 and 95% in experiment 2, and common grackles and blue jays accounted for 11% in experiment 3A. However, the numbers of other species were not sufficient, in comparison to house sparrow numbers, to obscure the control versus lines difference in food consumption ($P < 0.001$). Lines apparently had a filtering effect in that some species, particularly European starlings, passed through whereas house sparrows did not. In an earlier experiment with grapes, failure of clear 5.4-kg test (CM) lines to repel birds was apparently related to the species present rather than to high visibility of lines (Steinegger et al. 1991).

In experiments 1 and 2, 7 house sparrows were counted in total on all stations with lines compared to 1,767 counted on the controls. Food may be limited for house sparrow populations in winter, a time when food intake increases in small birds and when long, cold winter nights can be critical (Beer 1961, Ken-

Table 2. House sparrows counted and bait consumption on stations protected by monofilament lines: effects of line type and spacing at 2 sites, Lincoln, Nebraska, 1989.

| Treatment | | Experiment number (site) | | | | | |
|---|---|---|---|---|---|---|---|
| | | 2 (barn) | | 3A (barn) | | 3B (farm) | |
| Line type[a,b] | Spacing (cm) | House sparrows counted ($\bar{x}$)[c] | Bait consumption (g) (all species) ($\bar{x}$)[c] | House sparrows counted[d] ($\bar{x}$)[c] | Bait consumption (g) (all species) ($\bar{x}$)[c] | House sparrows counted ($\bar{x}$)[c] | Bait consumption (g) (all species) ($\bar{x}$)[c] |
| CM | 30 | 0.0 | 8.3 | 2.2 | 11.0 | 4.8 | 7.0 |
| CM | 60 | 0.2 | 12.5 | 6.0 | 24.3 | 5.8 | 12.8 |
| YH | 30 | 0.0 | 9.1 | 11.0 | 21.8 | 4.4 | 5.9 |
| YH | 60 | 0.2 | 7.4 | 16.0 | 17.7 | 3.4 | 7.3 |
| Control | | 186.8*** | 78.8*** | 191.6*** | 142.6*** | 77.2*** | 38.4*** |

[a] CM = clear, moderate-weight (5.4-kg test, 0.34-mm diam); YH = fluorescent yellow, heavier weight (9-kg test, 0.46-mm diam).
[b] All lines were oriented north–south and stretched horizontally 17 cm above the food.
[c] Values given are means across 5 3-day periods.
[d] In experiment 3A, the mean number of house sparrows counted differed between CM and YH lines ($P = 0.001$) and between 30- and 60-cm treatments ($P = 0.049$).
*** Different from mean of treatments ($P < 0.001$).

deigh et al. 1977). Although we lack specific data on food availability in our experiments, no easily accessible food source, other than the stations, was apparent. Moreover, lines repelled house sparrows from sites where food was usually consumed during pretreatment. Thus, despite apparent food needs, house sparrows in these winter experiments virtually did not feed on stations with lines.

Proportions of house sparrows feeding on control stations were lower in 3A and 3B than in experiments 1 and 2 ($P < 0.001$); whereas, 3A and 3B did not differ ($P = 0.277$) (Table 3). Habituation might account for the reduced effectiveness observed at the barn site in experiment 3A, in comparison to experiment 2, but habituation cannot account for the similar response at the 3B (farm) site. In addition, differences in feeding pressure do not account for the reduced effectiveness of lines in experiment 3B, in comparison to experiment 2 (barn), because the 3B site had lower bird counts. These results do not rule out habituation as a reason for the change in response observed at the barn (3A) site. In other studies, however, birds that have been effectively repelled by wires or lines, particularly some gull species, have shown little habituation over time. For example, lines in place over sanitary landfills for 1 year (McLaren et al. 1984) or 4 months (Dolbeer et al. 1988) and over reservoirs for up to 8 years (Amling 1980) continued to repel certain species of gulls.

The reduced effectiveness of lines in experiment 3 may be linked to reproductive activities and to the presence of hatching-year juveniles during May and June when this experiment was conducted. Other studies have reported that hatching-year juvenile gulls may pass under lines more readily than adults (Blokpoel and Tessier 1984, McLaren et al. 1984). In our experiment 3A, 90% of the house sparrows counted on stations with lines were juveniles or females. In experiment 3B, all house sparrows observed on stations with lines were juveniles or females and, because of juvenile begging behavior, were identified primarily as

Table 3. Proportion of house sparrows counted on the control feeding station during 4 experiments conducted during 2 seasons, Lincoln, Nebraska, 1989–1990.

| Experiment | Site | Season | House sparrows counted (total) | Control station[a] (%) |
|---|---|---|---|---|
| 1 | Barn | Winter | 838 | 99.4 |
| 2 | Barn | Winter | 936 | 99.8 |
| 3A | Barn | Nesting | 1,134 | 84.5 |
| 3B | Farm | Nesting | 478 | 80.8 |

[a] Experiments were compared using analysis of variance and contrasts on rank transformations of per-period proportions. Values in experiments 1 and 2 were larger than those of 3A and 3B ($P < 0.001$), but 3A and 3B did not differ ($P = 0.277$).

juveniles. Of 3 juveniles observed hitting clear, 60-cm spacing line, 1 became momentarily entangled in it. We also observed female house sparrows delivering food, obtained on or away from bait stations, to young on stations with lines. We do not have complete sex-age data for control stations, but few adult males were observed on bait stations during experiment 3. Juveniles and adults tending to them may partly account for the higher numbers of house sparrows under lines during this experiment, a result similar to that of McLaren et al. (1984) in their research with gulls. They suggested that young gulls likely have higher food requirements than adults, possibly less efficiency and success in foraging, and that they may not have learned to be as wary of unusual situations.

Regarding adults, Summers-Smith (1963) reported a marked increase in the number of adult house sparrows trapped during the breeding season and suggested that, because of breeding activities and less time for finding food, they become less wary and more susceptible to entering a trap. He also showed a similar peak in captures of juveniles during this time. Hence, reduced adult wariness during the breeding season in our study may also have contributed to the reduced repellency of lines in experiment 3.

In experiment 3A, house sparrows were repelled least by highly visible ($P = 0.001$) and widely spaced ($P = 0.049$) lines, a result that differed from experiments 2 and 3B in which the same treatments showed no response differences. Reasons for this are unclear. However, experiment 3A (nesting season) differed from experiment 2 (winter) because of season and because of the proportion of house sparrows that used stations with lines. Experiment 2 had essentially no house sparrows on treatment stations, so differences among treatments, even if true, would not have been evident. Experiment 3A differed from 3B by location and by total house sparrows counted on stations. Total house sparrows counted at the barn (3A) site remained similar throughout experiments 1 (838), 2 (936), and 3A (1,134), but were lower at the 3B site (478). Higher bird use of stations at the 3A site could result in greater feeding pressure and more impetus to use stations with lines, whereupon house sparrows would select stations with the lowest perceived risk (Cuthill and Guilford 1990). Additionally, possible house sparrow habituation to lines at the 3A site or other factors such as greater familiarity with human activity in relation to house sparrow wariness (Summers-Smith 1963:213) might also have contributed.

Reasons why lines repel certain birds is not fully understood, and there are no apparent overall patterns among species that explain species-specific responses to lines (Pochop et al. 1990). For some species, body size and wingspan in relation to distance between lines may be a critical aspect of repellency (McAtee and Piper 1936, Dolbeer et al. 1988). For house sparrows, monofilament lines apparently do not present a clear physical barrier, because both 30 and 60 cm spacings are greater than their approximately 24-cm wingspan (Roberts 1974). Moreover, larger species (e.g., European starlings) readily went through these spacings. Lines may represent a physical obstruction that interferes behaviorally with house sparrows in making rapid escape, a point consistent with their extreme wariness and attentive responses in regard to predators and other potential hazards (Summers-Smith 1963, Dennis 1978). This wariness and tendency for rapid escape may be less developed in juveniles and may be suppressed in adults during the reproductive season. Thus, lines perhaps would be least effective during the breeding season when juveniles are present and adults less wary. Moreover, the biological use of the site where lines are placed may also affect house sparrow response. For example, recent studies (Pochop et al. 1991) indicate that lines do not repel house sparrows from nest boxes, which are sites likely selected because they are relatively secure from predation. Lines may repel house sparrows most effectively from open areas such as feeding sites where perceived risk of predation and associated need for rapid escape would be high.

House sparrows often conflict with the interests of people because they consume and contaminate stored grains and livestock feeds, consume grains and fruits in fields, cause unsanitary and objectionable conditions from nests and droppings in and around buildings, cause pecking damage to blown-on ceiling insulation, compete with native birds for nest cavities, roost in flocks in trees or buildings, and interfere with other birds or homeowner goals at backyard feeding stations (Dennis 1978, Fitzwater 1983). Our results indicate that lines have potential as an effective yet simple and environmentally-appealing technique to prevent house sparrow access to outdoor feeding sites, at least during winter months. Potential applications might include outdoor livestock feeders and, because of the species-specific response, backyard feeding stations (Kessler et al. 1991). Lines may be less effective with house sparrows during the nesting season but would likely have utility even then, particularly if used with other techniques. For example, if line effectiveness varies with perceived risk and need, it would likely be enhanced by increasing perceived risk (e.g., frightening devices) or lowering need (e.g., alternative food). Placement of lines in relation to the angle of house sparrow approach may warrant further study. Lines have repelled house sparrows when the approach was from above (this study) or the side (Kessler et al. 1991). Repellency of overhead lines when birds might approach from below has not been studied with house sparrows but has been successful with ring-billed gulls (*Larus delawarensis*) (Blokpoel and Tessier 1984).

## SUMMARY AND CONCLUSIONS

We conducted 3 experiments to evaluate repellency of monofilament lines to house sparrows at feeding stations. The first evaluated clear lines with light (CL) or moderate (CM) test-weights and 2 orientations (north–south, east–west); the second, CM and fluorescent yellow heavier-weight (YH) lines, each with 2 spacings (30 and 60 cm); and the third, using the same treatments as in experiment 2, examined responses during nesting season using 2 house sparrow populations. Results of house sparrow counts showed that lines effectively repelled house sparrows in all experiments ($P < 0.001$). Similarly, bait consumption was higher on control stations than on those with lines ($P < 0.001$), but bait consumption was affected by small numbers of other species, particularly European starlings that were not repelled by lines ($P \geq 0.86$). Results during nesting season (May–Jun) from 2 sites showed higher proportions of house sparrows under lines than were observed in earlier experiments (Dec–Feb), a result that appears related to reduced wariness of adults and presence of juvenile birds during the reproductive season. Comparisons among line treatments showed no differences in house sparrow counts ($P \geq 0.608$) except in experiment 3A where CM had fewer house sparrows than did YH ($P = 0.001$), and 30-cm spacing had fewer than did 60-cm ($P = 0.049$). Reasons for these differences among line treatments in experiment 3A are unclear but may relate to the higher house sparrow counts at the 3A site and increased breeding-season use of stations with lines. For house sparrows, it appears that lines are not frightening *per se* but rather function as a physical-behavioral barrier that interferes with rapid escape from potential danger. Potential applications might include use to discourage house sparrow activity at sites such as livestock feeders and backyard bird feeders, particularly during non-nesting periods. Research evaluating bird response to lines should consider possible seasonal effects due to reproduction.

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