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# THE STATUS OF LINES IN BIRD DAMAGE CONTROL-A REVIEW

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ABSTRACT: One technique for repelling or excluding birds is to stretch wires, monofilament lines, or nylon strings across sites needing protection. Wires or lines spaced at various intervals and in various configurations have successfully repelled birds such as ring-billed (Larus delawarensis) and/or herring (L. argentatus) gulls, and brant (Branta bernicla bernicla) from reservoirs, sanitary landfills, fish hatcheries, nesting areas, public places, or farm fields. Black thread has been suggested for repelling small birds such as sparrows (unspecified) from garden seedlings and bullfinches (unspecified) from fruit trees. Recent observations in New Mexico indicated that monofilament lines spaced at 30-cm (1-ft) intervals repelled house sparrows (Passer domesticus) and other birds from various feeding sites and barn swallows (Hirundo rustica) from nesting sites. Experiments in Nebraska have tested size (1.8-, 5.4-, and 9-kg test), color (clear and fluorescent golden), orientation (north-south, east-west, horizontal, vertical) and/or spacing (30 and 60 cm) of monofilament lines in a grape vineyard and at feeding stations. Results of food consumption and bird count data indicate that all treatments repelled house sparrows. Although the reasons lines repel certain birds is not fully understood, it appears that they have probable applications for excluding or repelling certain terrestrial as well as aquatic species.

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## INTRODUCTION

Bird damage complaints typically result from economic losses or nuisance situations associated with different bird species. Nonlethal control techniques that are cost-effective, long-lived, and safe are becoming increasingly important in situations where lethal techniques are not desirable or practical (Schmidt 1989).

One method that has been used to control bird damage is the use of widely spaced lines or wires placed over or around sites needing protection. Many types of lines have been used to control bird damage at different sites but various spacings and heights affect species differently. The purpose of this paper is to provide an overview of the current status of lines in repelling or excluding birds.

## METHODS-HOW LINES HAVE BEEN USED

The use of lines to control bird damage over city water supply reservoirs started as early as 1927 in British Columbia (McAtee and Piper 1936). The lines were attached to posts at the perimeter of reservoirs and arranged in grid patterns ranging in size from 6.1 × 6.7 m (20 × 22 ft) to 9 × 9 m (30 × 30 ft). The lines were pulled as tight as possible and attached at heights of approximately 4.6 m (15 ft) above the high-water mark. This system was effective in preventing gull (unspecified) access and associated contamination of the water supply (McAtee and Piper 1936). Since then, lines of many types of materials in various spacings, heights, and installation patterns have been used at different sites with varying results.

Selection of lines has varied with the intended use. Because of their strength, nonrusting wires, ranging in size from 0.25 to 5.1 mm in diameter (0.01-0.20 in dia.; ~32-6 gauge U. S. standard) have typically been used at sites such as reservoirs (McAtee and Piper 1936, Amling 1980), fish hatcheries (Lagler 1939, Salmon and Conte 1981, Barlow and Bock 1984), crop fields (Wright 1958), public places (Blokpoel and Tessier 1984), landfills (Forsythe and Austin 1984, Laidlaw et al. 1984, McLaren et al. 1984, Dolbeer et al. 1988), and a sewage lagoon (L. E. Terry 1984, unpubl. report). Black cotton thread has been suggested for use to protect hedgerows (English 1953), fruit trees (Healey and Davis 1972), flower buds (Genders 1976), crops (Seymour 1979) and seedlings (Bunting et al. 1978, Larkom 1986). Nylon strings have been used over fields (Pfeiffer 1977) and fish ponds (Moerbeek et al. 1987) but had severe problems with breakage over a reservoir (Amling 1980). Plastic wires of 1.75 and 3.5 mm diameter (0.07 and 0.14 in dia.; 15 and 10 gauge U. S. standard) have been used over a lake (L. L. Walker 1988, unpubl. report). Monofilament lines ranging from 1.8- to 23-kg test (4- to 50-lb test) have been used at fish hatchery raceways (Ostergaard 1981), nest sites (Blokpoel and Tessier 1983, J. E. Knight 1989, pers. comm.), public places (Blokpoel and Tessier 1984), a lake shoreline (C. E. Faulkner 1989, pers. comm.), grape plants, and other feeding sites (J. E. Knight 1989, pers. comm.; Aguero et al. 1989). Nine-kg (20-lb) test fluorescent golden or yellow monofilament lines have been used at feeding stations (Aguero et al. 1989) and in citrus groves (Rappole et al. 1989, Tipton et al. 1989). Lines, wires, and cables in larger sizes have also been used, but their primary purpose was to support the finer lines (McAtee and Piper 1936; Blokpoel and Tessier 1983, 1984; Rappole et al. 1989; Tipton et al. 1989).

Spacing, height, and installation pattern of the lines typically depend on the species to be repelled. General trends are that wider spacings (>3 m) have been used with larger species (e.g., body length >25 cm and wingspan >60 cm) and narrower spacings (<1 m) with smaller species (e.g., body length <30 cm and wingspan <50 cm). Heights have generally been determined by use requirements of the site to be covered (up to 24 m at landfills). Installation patterns have generally been grids for wider spacings and parallel lines for narrower spacings although variations of patterns have also been used.

## RESULTS-BY SITE

Lines have been used over several types of water features (Appendix 1). In early studies, gulls (unspecified) were seen occasionally settling on reservoirs protected by 9 × 9-m (30 × 30-ft) wire grids but never with 6.1 × 6.7-m (20 × 22-ft) grids (McAtee and Piper 1936). Wires spaced 15 to 24 m (50 to 80-ft) apart and 2 to 3 m (8 to 10 ft) above the water immediately repelled gulls (unspecified) from reservoirs in California (Amling 1980). Parallel monofilament lines spaced 41 cm (16 in) apart and 20 cm (8 in) high prevented herring gulls from landing in the water of fishery raceways (Ostergaard 1981). Canada geese (Branta canadensis) have been repelled by parallel lines spaced 6 m (20 ft) apart over a sewage lagoon in Virginia (L. E. Terry 1984, unpubl. report). American wigeon (Anas americana), canvasback (Aythya valisinera) and lesser scaup (A. affinis) numbers have been reduced on ponds with a 6 × 6-m (20 × 20-ft) grid system placed over the water (L. E. Terry 1984, unpubl. report). To a lesser degree, mallards (Anas platyrhyncos), black ducks (A. rubripes), green-winged teal (A. crecca), blue-winged teal (A. discors), ring-necked ducks (Aythya collaris), hooded mergansers (Lophodytes cucullatus), and ruddy ducks (Oxyura jamaicensis) have been repelled from ponds with a 3 × 3-m (10 × 10-ft) grid, but wood ducks (Aix sponsa) and bufflehead (Bucephala albeola) were not repelled (L. E. Terry 1984, unpubl. report). Plastic wires in 9-m (30-ft) grids repelled Canada geese from a lake in Nevada (L. L. Walker 1988, unpubl. report) and monofilament lines stretched parallel between stakes at 15 and 30 cm (6 and 12 in) heights discouraged Canada geese from grazing on lawns next to a lake in Virginia (C. E. Faulkner 1989, pers. comm.). Observations revealed only a small number of redheads (probably Aythya americana) and blue bills (probably greater scaup A. marila or lesser scaup A. affinis) on a lake in Nevada with lines spaced 9 m (30 ft) apart (L. L. Walker 1988, unpubl. report). Nylon lines spaced 10 to 20 m (33 to 66 ft) apart in several installation patterns and 30 to 40 cm (12 to 16 in) above a fish pond in the Netherlands did not prevent cormorants (Phalocrocorax carbo sinensis) from landing (Moerbeek et al. 1987).

Lines have been found to be effective in repelling some species from landfills. Preliminary observations at a landfill in New York indicate that parallel lines spaced 3 m (10 ft) apart and 24 m (80 ft) high successfully repelled herring and great black-backed (Larus marinus) gulls but not laughing gulls (L. atricilla), American crows (Corvus brachyrhyncos), rock doves (Columba livia) or European starlings (Sturnus vulgaris) (Dolbeer et al. 1988). Ring-billed and herring gulls were effectively excluded from a landfill in New York by wires spaced 6 m (20 ft) apart and 10 m (33 ft) high (Laidlaw et al. 1984, McLaren et al. 1984). A wire system with lines spaced 6 m (20 ft) apart over the active area of a landfill in South Carolina effectively reduced numbers of ring-billed gulls, fish crows (Corvus ossifragus) and American crows (Forsythe and Austin 1984).

Lines have been used over public places such as outdoor restaurants, a pool, a roller-skating rink, a picnic area, and walkways. Both monofilament lines and wires were successful in excluding ring-billed gulls from public places in Toronto, Canada, when installed in an irregularly criss-crossing network or spaced 2.5 m (8 ft) apart and at heights of 3 to 10 m (10 to 33 ft). However, rock doves were not repelled by wires at these spacings (Blokpoel and Tessier 1984).

Throughout the years, lines have been used over various types of crops. Pigeons (unspecified) and rooks (unspecified) were effectively deterred from crops in Great Britain with wires spaced 11 m (36 ft) apart in a parallel and zigzag pattern at a height of 1.5 m (5 ft) (Wright 1958). Sparrows (unspecified) appeared to be frightened by black cotton thread spaced 2.5 cm (1 in) apart and 2.5 m (8 ft) high in hedgerows or in the shelter of trees (English 1953). Citrus groves in Texas protected with monofilament lines placed in grids 3 to 11 m (10 to 36 ft) apart and 1 m (3 ft) above the canopy had less damage from great-tailed grackles (Quiscalus mexicanus) than did control groves; however in this case preliminary results indicated that lines would have been cost-effective only when damage levels were high (Tipton et al. 1989). In the Netherlands, brant did not fly into fields protected with nylon strings spaced 12 to 16 m (39 to 52 ft) apart at right angles to the prevailing wind direction and about 1 m above the ground (Pfeiffer 1977). Thread spaced approximately 23 cm (9 in) apart and placed directly on trees in England reduced bullfinch (probably Pyrrhula pyrrhula) damage to pears (Healey and Davis 1972).

Observations in New Mexico indicate that monofilament lines spaced approximately 30 cm (1 ft) apart stopped house sparrow and other bird (unspecified) damage to strawberries, grapes, and peaches (J. E. Knight 1989, pers. comm.). Experiments in Nebraska with monofilament lines tested size (1.8-, 5.4-, and 9-kg test), orientation (north-south, east-west, horizontal, vertical), color (clear and fluorescent golden), and spacing (30 and 60 cm) at feeding sites (Aguero et al. 1989). Results of food consumption and bird count data at feeding stations indicate that all treatments repelled house sparrows, but monofilament lines at 30 cm (1 ft) spacings around grape plants did not prevent American robin (Turdus migratorius) or European starling damage to grapes.

Lines have repelled some bird species from nesting sites. Ring-billed gulls were effectively repelled from traditional nesting sites by monofilament lines running parallel at 60 cm (2 ft) spacings and at 60 or 120 cm (2 or 4 ft) heights. On average, there were 3.0, 3.8, and 224 nests in the high exclosures (120 cm high), low exclosures (60 cm), and control plots (no lines), respectively (Blokpoel and Tessier 1983). Spacings of 30 cm (1 ft) effectively stopped barn swallow nesting under eaves of a house (J. E. Knight 1989, pers. comm.). However, monofilament lines installed in 3 to 11 m (10 to 36 ft) grids to control great-tailed grackle damage produced no significant reduction in nesting success of mourning doves (Zenaida macroura) (Rappole et al. 1989).

## DISCUSSION

It is apparent that lines do not repel all species of birds. McLaren et al. (1984) concluded that the success of wires as a deterrent varies with species, season, wire spacing, and amount of edible food present. The potential factors involved in the success of lines are discussed below.

One question that arises is why lines repel certain bird species and not others. McAtee and Piper (1936) suggested that the correct distance between cross wires would depend greatly upon the species to be repelled. They thought that wires spaced at twice the wingspread of a species would be a sure deterrent but that actual effective spacing would also depend upon behavior. Dolbeer et al. (1988) also thought that size of the bird may be a critical factor. In experiments with parallel lines they speculated that there may be "... a threshold in wingspan between 41 inches (laughing gull) and 55 inches (herring gull) that marks the effective limit for exclusion when wire spacing is 10 feet." However, Terry (1984 unpubl. report) found that hooded mergansers with a narrower wingspan [24 to 26.5 in (61 to 67 cm)] could be excluded by the same size grid. Aguero (1990) found that species larger and smaller than house sparrows penetrate lines that repel the latter. Therefore, even though the general trend is for wider spacings to be used with larger birds and narrower spacings with smaller birds, size is only part of the answer.

The height of lines generally has been determined by use of the area to be protected. However, as yet there is no apparent relationship between spacing and height of lines in repelling various bird species. Further work with various sites and species is needed to determine whether specific heights are more effective than others and whether there is a relationship between effectiveness and the spacing-height ratio.

Blokpoel and Tessier (1984) speculated that flying gulls looking for food focus their eyes on the ground and unexpectedly fly into a line when circling or gliding down. This indicates that gull aversion to lines may be a behavior learned in part from flying into a line. However, this does not explain completely why some bird species apparently avoid lines without any attempt to fly through. Amling (1980) made a related observation that certain gulls from incoming flocks would descend close to the reservoir as if surveying, then return to the flock and all would depart. Although learning from other birds is probable, the immediate and near total exclusion reported for some gulls (Amling 1980) and house sparrows (Aguero 1990) indicates a more powerful mechanism for these species.

Some individuals appear to be more likely than groups of birds to penetrate lines (McAtee and Piper 1936). Occasionally sick or injured birds go through lines (Amling 1980) and some individuals walk in under lines from the ground (McAtee and Piper 1936, Blokpoel and Tessier 1984, Forsythe and Austin 1984). Also, preliminary observations indicate that laughing gulls may be excluded by lines initially but may later adapt to them (Dolbeer et al. 1988). However, ring-billed gulls (Blokpoel and Tessier 1984, McLaren et al. 1984) and house sparrows (Aguero 1990) do not appear to habituate to lines.

In two reports on gulls penetrating lines, 20 to 50% (McLaren et al. 1984) and 50 to 80% (Blokpoel and Tessier 1984) were young-of-the-year, indicating that young birds are less likely to avoid lines. McLaren et al. (1984) suggested that older gulls may have learned to be wary of unusual situations and that the success of lines was partially related to season. They noted that although in summer the numbers of feeding gulls were substantially reduced, the deterrent effect was less marked than at other seasons. McLaren et al. (1984) speculated that food requirements of young and therefore their motivation for penetrating the wires are likely higher than those of adults. Whether young birds that penetrate the lines also penetrate them as adults remains unknown (McLaren et al. 1984). Somewhat in contrast, Wright (1958) showed that pigeons (unspecified) were repelled by lines from crops in spring as effectively as in the winter, but ages were not reported.

The attractiveness of a site and availability of alternative resources may also affect the success of lines. Blokpoel and Tessier (1984) noted that virtually all gulls present in one public area covered by lines were being fed by people. McLaren et al. (1984) were not certain that herring gulls would be effectively deterred when attracted by large amounts of food and Terry (1984 unpubl. paper) questioned whether wire grids would keep waterfowl from using a pond if that pond was the only body of water in the area. However, Blokpoel and Tessier (1983) speculated that lines would still repel gulls if all nesting habitat was covered instead of selected plots as in their study, but that the gulls would be more persistent, possibly resulting in entanglements.

The wariness of birds and the idea of interference from lines in making a rapid escape is another potential basis for their efficacy and is consistent with observed behavior. Gulls that penetrated lines appeared more apprehensive after the lines were installed than before (Amling 1980, Forsythe and Austin 1984, Laidlaw et al. 1984) and brant may avoid fields with lines because they cannot fly up freely in all directions (Pfeiffer 1977). It is possible that Canada geese must see the lines to avoid them (L. E. Terry 1984, unpubl. report). Rapid escape would require sufficient clear flight space and knowledge of where the space was located. Thus, the installation pattern and visibility of lines might affect the ease of escape, wariness, and line efficacy for a particular bird species.

An area not clearly addressed in the literature is the relationship between type or category of activity and effectiveness of lines. For example, would nesting success of the gulls in Blokpoel and Tessier's (1983) study have been the same if the lines had been spaced as far apart as in the studies where feeding or loafing was the primary activity? Also unanswered is whether lines are effective in preventing some bird species from roosting and whether there are relationships among effectiveness, length of time a site has been used, season, and other factors.

There are no apparent patterns among species that explain the efficacy of lines in repelling various birds. Size of the bird may be a partial answer but contributions of specific traits among species remain unknown. Salmon and Conte (1981) provided descriptions of size, appearance, feeding, and behavior of several fish-eating birds to help managers of aquaculture facilities recognize damage-causing species and therefore possible methods of control. More detailed information on species-specific responses will greatly enhance understanding and use of lines as a management tool.

## CONCLUSIONS

Lines used to repel birds have been made of many types of materials depending on intended use and cost. Spacing, height, and installation pattern have varied with site and species to be repelled. Several gull species, Canada geese, brant, house sparrows, and others have been repelled from various feeding and loafing sites. Much less is known about bird response to lines at nesting and especially roosting sites. Morphological and behavioral patterns among species may help provide insights into the mechanisms that make lines effective but further information on species-specific response to lines is needed.

Lines can be a useful method to control certain bird damage problems. However, more information is needed before the underlying mechanisms and the most effective and appropriate application procedures can be fully understood. We encourage researchers, managers, and others who deal with lines to record the species involved; types of lines used; line spacing, height, and installation pattern; site description; bird behavior; method of analysis; and other pertinent observations. Such data will help provide a better basis for understanding how best to use this technique in safe and effective damage control.

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Appendix 1

This appendix is an annotated list of species that have been present at sites where lines have been used. The repellency affect of the lines is noted for each species. The list includes other pertinent information in the following format:

species
line material (size and color when given)
site or damage problem, location
line spacing, installation pattern, and height -- repellency effect
literature reference
specific remarks (where needed for clarity)

Information categories not available from a report are indicated as not reported.

**great cormorant**
nylon line
fish ponds, Netherlands
20 x 20-m grid, 30 to 40 cm above water -- **somewhat repelled**[a]
10 x 10-m grid, 30 to 40 cm above water -- **somewhat repelled**[a]
20 x 20-m grid, overhead -- **somewhat repelled**[a]
irregular pattern, overhead -- **somewhat repelled**[a]
lines diverging from 2 support poles in a tent pattern to 14 to 15 m spacing at the sides -- **somewhat repelled**[a]

(Moerbeek et al. 1987)

[a]The above line constructions did not prevent great cormorants from landing. However, the authors reported that lines appeared to change cormorant behavior and that narrower line spacings appeared to have a greater deterrent effect than wider.

**Canada geese**
wire [0.38 mm dia. (0.015 in dia.; ~28 gauge U.S. standard)]
sewage lagoons, Virginia
6 m apart, parallel, height not reported -- **repelled**

(L. E. Terry 1984, unpubl. report)

plastic wire [3.5 mm dia. (0.14 in dia.; 10 gauge U.S. standard ) and 1.75 mm dia. (0.07 in dia.; 15 gauge U.S. standard), black]
lake, Nevada
9 x 9-m grid, height not reported -- preliminary results: **repelled**

(L. L. Walker 1988, unpubl. report)

monofilament line [9-kg test (20-lb test)]
lake shoreline, Virginia
fence pattern - stakes 1.8 m apart; lines 17 and 31 cm above ground -- preliminary results: **repelled**

(C. E. Faulkner 1989, unpublished report)

**brant**
nylon string
crop fields (grass grown for seed production and cereals), Netherlands
12 to 16 m apart, parallel, 1 m above ground -- **repelled**

(Pfeiffer 1977)

**American widgeon, canvasback and lesser scaup**
wire [0.38 mm dia. (0.015 in dia.; ~28 gauge U.S. standard]
sewage lagoon, Virginia
6 x 6 m grid, height not reported -- **repelled**

(L. E. Terry 1984, unpubl. report)

mallard, black duck, green-winged teal, blue-winged teal, ring-necked duck, hooded merganser, and ruddy duck

wire [0.38 mm dia. (0.015 in dia.; ~28 gauge U.S. standard)]
sewage lagoon, Virginia
3 x 3-m grid, height not reported -- **somewhat repelled**[b]

(L. E. Terry 1984, unpubl. report)

[b]Observations indicate that these species may have been somewhat repelled by the 3x3 m grid, but low numbers of some species and other confounding factors were such that the observed effects could not be clearly attributed to lines.

wood duck and bufflehead

wire [0.38 mm dia. (0.015 in dia.; ~28 gauge U.S. standard)]
sewage lagoon, Virginia
3 x 3-m grid, height not reported -- **not repelled**

(L. E. Terry 1984, unpubl. report)

black vulture

monofilament line [4.5 kg test (10 lb test), white]
damaged plastic on roof of building, Florida
1.8 m apart, parallel, 1.2 m above roof -- **repelled**

(J. Boccardy 1989, personal comm.)

ring-billed gull

monofilament line [18 kg test (40 lb test)] and wire [2 mm dia. (0.08 in dia.; ~14 gauge U.S. standard)]
nesting areas, Canada
60 cm apart, parallel, 60 cm above ground -- **repelled**
60 cm apart, parallel, 120 cm above ground -- **repelled**

(Blokpoel and Tessier 1983)

wire [2 mm dia. (0.08 in dia.; ~14 gauge U.S. standard)] and stainless steel fishing line [0.25 mm dia. (0.01 in dia.; ~32 gauge U.S. standard)]
public places (e.g. outdoor pool, restaurant, arches over walkways, etc.), Canada
2.5 m spacing (installation pattern not recorded), 8 to 10 m above ground -- **repelled**

(Blokpoel and Tessier 1984)

monofilament line
public places (e.g. outdoor restaurant, fast food outlets, picnic area, roller-skating rink, etc.), Canada
criss-crossing network, 3 to 5 m above ground -- **repelled**

(Blokpoel and Tessier 1984)

wire
landfill, South Carolina
6 x 6 m grid, over actively used area -- **repelled**

(Forsythe and Austin 1984)

wire [0.8 mm dia. (0.032 in dia.; ~22 gauge U.S. standard]
landfill, New York
12 m apart, parallel, 10 m above ground -- **somewhat repelled**[c]
6 m apart, parallel, 10 m above ground -- **repelled**

(McLaren et al. 1984)

[c]The authors report that ring-billed gulls were still able to penetrate the lines at this 12 m spacing.

__herring gull__
monofilament line [23 kg test (50 lb test)]
fish hatchery raceways, Pennsylvania
41 cm apart, parallel, 20 cm above water -- **repelled**

(Ostergaard 1981)

wires [0.8 mm dia. (0.032 in dia.; ~22 gauge U.S. standard)]
landfill, New York
12 m apart, parallel, 10 m above ground -- **repelled**

(McLaren et al. 1984)

wire [2.35 to 3.91 mm dia. (0.09 to 0.16 in dia.; ~13-9 gauge U.S. standard)]
landfill, New York
3 m apart, parallel, 24 m above ground -- preliminary results: **repelled**

(Dolbeer et al. 1988)

__great black-backed gull__
wire [2.35 to 3.91 mm dia. (0.09 to 0.16 in dia.; ~13-9 gauge U.S. standard)]
landfill, New York
3 m apart, parallel, 24 m above ground -- preliminary results: **repelled**

(Dolbeer et al. 1988)

__laughing gull__
wire [2.35 mm dia. (0.09 to 0.16 in dia.; ~13-9 gauge U.S. standard)]
landfill, New York
3 m apart, parallel, 24 m above ground -- preliminary results: **not repelled**[d]

(Dolbeer et al. 1988)

[d]The report indicated that laughing gulls, after an initial confrontation with the lines, may be adapting to them.

__rock dove__
wire [2 mm dia. (0.08 in dia.; ~14 gauge U.S. standard)] and stainless steel fishing line [0.25 mm dia. (0.01 in dia.; ~32 gauge U.S. standard)]
public places (e.g. outdoor pool, restaurant, arches over walkways, etc.), Canada
2.5 m spacing (installation pattern not reported), 8 to 10 m above ground -- **not repelled**

(Blokpoel and Tessier 1984)

monofilament line
public places (e.g. outdoor restaurant, fast food outlets, picnic area, roller-skating rink, etc.), Canada
criss-crossing network, 3 to 5 m above ground -- **not repelled**

(Blokpoel and Tessier 1984)

wire [2.35 to 3.91 mm dia. (0.09 to 0.16 in. dia.; ~13 to 9 gauge U.S. standard)]
landfill, New York
3 m apart, parallel, 24 m above ground -- preliminary results: **not repelled**

(Dolbeer et al. 1988)

__pigeon__ (possibly rock dove)
wire [0.5 mm dia. (0.02 in dia.; 24 gauge U.S. standard)]
crops (spring cabbage, peas, broccoli), Great Britain
11 m apart, parallel and zigzag pattern, 1.5 m above ground -- **repelled**

(Wright 1958)

__mourning dove__
monofilament line [9 kg test (20 lb test), fluorescent yellow] and nylon line (size 24)
nesting success in citrus groves, Texas
3 x 3-m grid, 1 m above canopy -- **not repelled**
7 x 7-m grid, 1 m above canopy -- **not repelled**
11 x 11-m grid, 1 m above canopy -- **not repelled**

(Rappole et al. 1989)

__barn swallow__
monofilament line [3.6 kg test (8 lb test), clear]
nesting under eaves of a house, New Mexico
30 cm apart, parallel or zigzag -- preliminary results: **repelled**

(J. E. Knight 1989, personal comm.)

__American crow__
wire
landfill, South Carolina
6 x 6-m grid, over actively used area -- **repelled**

(Forsythe and Austin 1984)

wire [2.35 to 3.91 mm dia. (0.09 to 0.16 in dia.; ~13-9 gauge U.S. standard)] landfill, New York
3 m apart, parallel, 24 m above ground -- preliminary results: **not repelled**

(Dolbeer et al. 1988)

__fish crow__
wire
landfill, South Carolina
6 x 6 m grid, over actively used area -- **repelled**

(Forsythe and Austin 1984)

__great-tailed grackle__
monofilament line [9 kg test (20 lb test), fluorescent yellow] citrus groves, Texas
3 x 3-m grid, 1 m above canopy -- **somewhat repelled**[e]
7 x 7-m grid, 1 m above canopy -- **somewhat repelled**[e]
11 x 11-m grid, 1 m above canopy -- **somewhat repelled**[e]

(Tipton et al. 1989)

[e]This preliminary report indicated that great-tailed grackles were repelled but lines may not be cost effective unless damage is high.

__American robin, European starling__
monofilament line [5.4 kg test (12 lb test), clear]
grape plants
30 cm apart, parallel, around plants -- **not repelled**

(Aguero et al. 1989, Aguero 1990)

__house sparrow__
monofilament line [3.6-kg test (8-lb test), clear]
strawberries, sprouting plants, and peach trees, New Mexico
30-cm spacing -- **repelled**
lines diverging from a center support pole in a tepee pattern to 60-cm spacing at ground -- **repelled**

(Knight 1988; J. E. Knight 1989, pers. comm.)

monofilament line [1.8- to 9-kg test (4- to 20-lb test), clear or fluorescent golden] feeding stations, Nebraska
30-cm apart, ~ 17-cm from food -- **repelled**
60-cm apart, ~ 17-cm from food -- **repelled**
(Aguero et al. 1989, Aguero 1990)