Evaluation of 2.4-m Fences and One-Way Gates for Reducing Deer-Vehicle Collisions in Minnesota

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Two segments of 2.4-m fence with one-way gates along new Interstate highways in Minnesota were evaluated for 18 months for their effectiveness in reducing deer-vehicle collisions. The fences were 4 and 5.1 km long with 9 and 10 pairs of gates, respectively. Passage by deer through the one-way gates was monitored by the use of baler counters and track beds. Sixty-nine percent of 51 passages through the gates were in a positive direction (from inside the fenced highway corridor to the outside). The reported number of deer hit was reduced 60 and 93 percent from the expected number in the two segments. A benefit-cost ratio of 3.61 appeared most appropriate for use in determining whether to erect such fences. Recommendations are made for design considerations in any future such fence construction.

Deer-vehicle collisions occur frequently when a new highway is opened through an area of high deer density or bisects an area used by deer in moving to and from feeding and resting areas. This increased mortality can result in the elimination of small populations of deer (1). Property damage, inconvenience, and personal injuries can cause severe problems for the motorists involved.

In some situations, fencing has proved effective in reducing the numbers of deer gaining access to highways (2). Whereas the standard 1.2-m highway fence is easily jumped by deer, 2.4-m fences have proved successful in reducing the numbers of deer gaining access to particularly troublesome stretches of highway (3,4). Where such deerproof fences are in short segments, however, some deer venture around the ends and get funneled into and entrapped on the highway corridor by the fence, eventually to become highway casualties. In such situations exits are needed to allow deer to leave the highway corridor. One-way gates (4) offer the greatest promise in this regard.

In 1978 the then Minnesota Department of Highways constructed two pilot segments of 2.4-m fence with one-way gates along new sections of Interstate highways. Cooperative evaluation of these projects by the Minnesota Department of Natural Resources (DNR) and Department of Transportation (MnDOT) was undertaken to determine whether such fences and gates could effectively reduce deer-vehicle collisions along future new highway segments.

OBJECTIVES

The purposes of this project were to determine the effectiveness of a 2.4-m fence in preventing deer access to the highways and to determine the effectiveness of one-way gates in facilitating the safe exits of any deer that gained access to the fenced highway corridors.

METHODS

The two projects were

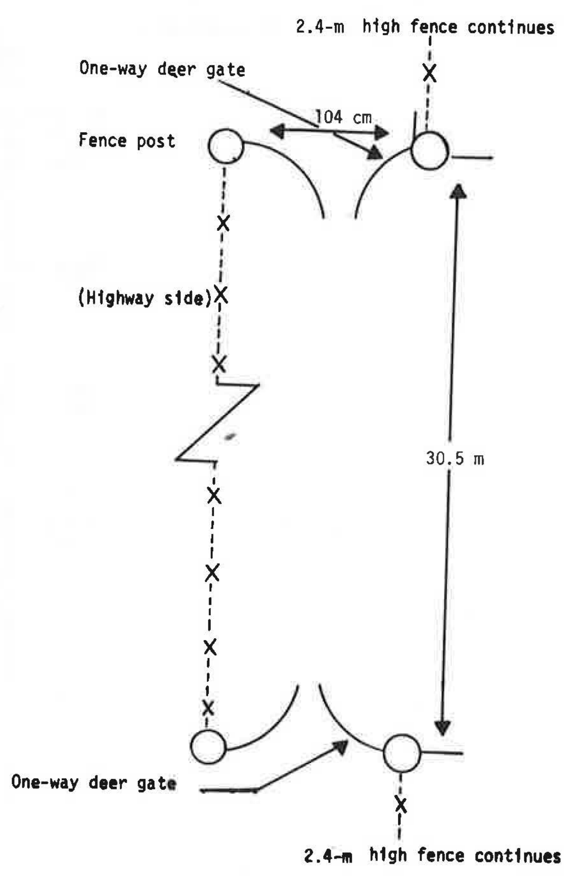
1. A 4-km segment along I-94 near St. John's College in Stearns County, which had 9 pairs of one-way gates, and
2. A 5.1-km segment along I-90 through the Walnut Lake Wildlife Management Area in Faribault County, which had 10 pairs of one-way gates.

Details of one-way gate design were as outlined by Reed, Pojar, and Woodard (4) and as shown in Figures 1-3. Gates were set in pairs facing in opposite directions with 30.5-m spacing between gates of a pair. Pairs of gates were located near each end of the fence segments and along the fences near locations where deer might gain access to, or possibly try to leave, the highway corridor.

All deer known to be killed in these highway corridors and near each end were recorded. An attempt was made to gather data on the behavior of the deer hit, but drivers did not stay at the site of the collision until they could be interviewed. The number of deer killed after fence construction was compared with the number killed along corresponding segments of the adjacent older highways during the previous year.

Effectiveness of the fence and gates was monitored by the use of counters and track beds. Small baler counters (International Harvester) were installed at each gate to register positive passages through the gates. Counters were checked and reset biweekly when conditions allowed. At the same time, deer tracks indicating travel in each direction were recorded from track beds created inside and outside each gate and at each end of the fence where it connected to the standard 1.2-m fence.

Figure 1. General design of pair of one-way deer gates.



Few data were available on deer behavior and movements before fence construction. In an attempt to evaluate deer density in areas of the fence projects, winter aerial counts were made when conditions allowed. To obtain some before-fence data on deer movements for comparison, several track counts were made on the unfinished highway segments 2 days after heavy rain or snow.

RESULTS AND DISCUSSION

Fence installation was completed, with gates and counters in place, by July 15, 1978. In the prior year, 15 deer were reported killed by cars along each old highway segment adjacent to the fenced areas. This does not take into account deer hit but not reported, either because they were not killed or

Figure 2. Top view of one-way gate and position of deer passage counter.

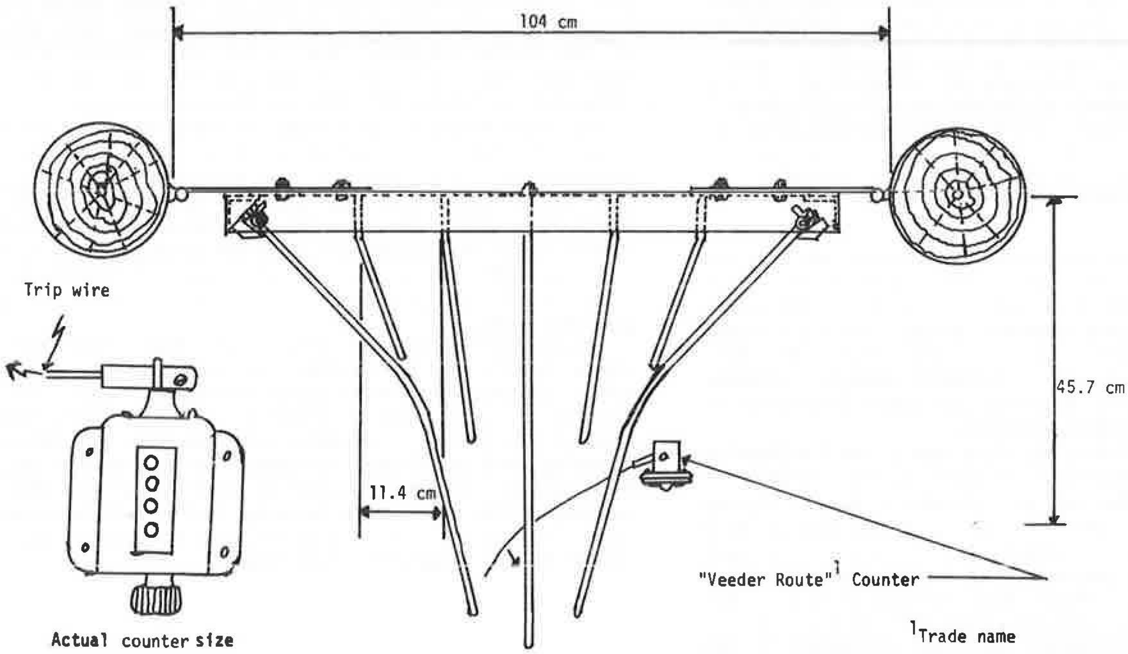
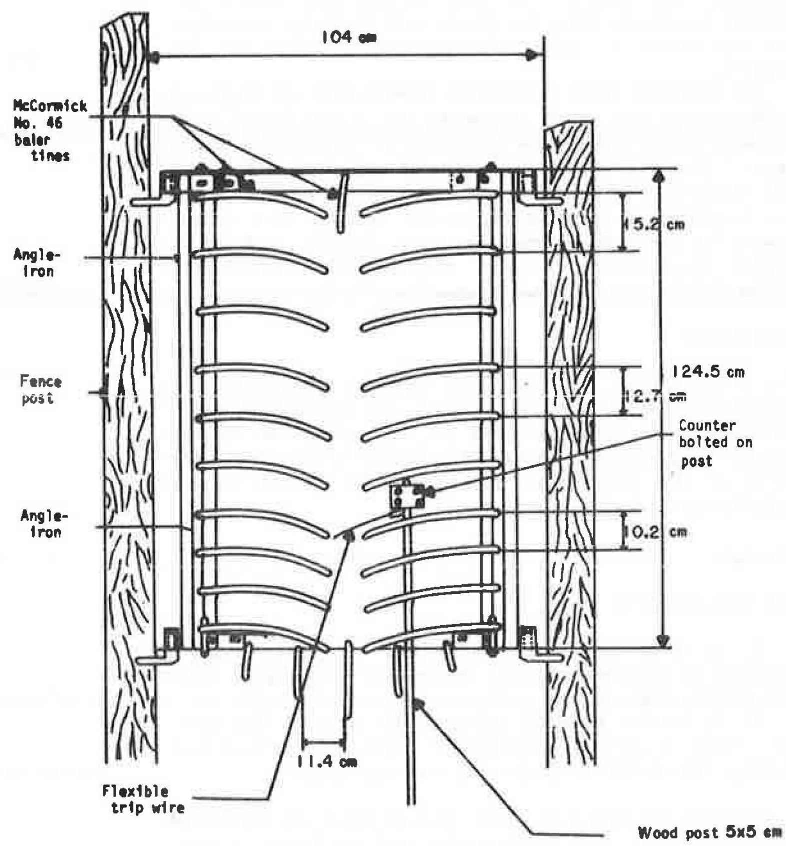


Figure 3. Front view of one-way gate with deer passage counter in position.



because they were picked up illegally. Local conservation officers estimated that unreported deer may have accounted for an additional one to two hit in the Walnut Lake area and four to five hit in the St. John's area. Track counts made before the fence construction--three at Walnut Lake and four at St. John's--revealed an average of 12.1 and 21.2 crossings per night of the to-be-fenced highway segments, respectively.

Counters and track beds at gates were monitored for 18 months. By this time several counters were nonfunctional in each area, and vandalism had become a problem at the St. John's project. Also, because of standing water, counters and track beds were never installed at six gates at Walnut Lake.

During the 18-month monitoring period, 25 positive passages (inside corridor to outside) and 8 negative passages (outside corridor to inside) by deer through the one-way gates were recorded at Walnut Lake, and 10 positive and 8 negative passages at St. John's. Reed, Pojar, and Woodard (4) reported that only 4 percent of passages through gates in Colorado was negative. The difference in this study (31 versus 4 percent) appears to be due to public interference with gates and to some damage by cattle and falling trees.

At Walnut Lake, 13 deer were reported killed by cars--12 inside the fenced corridor and 1 just outside the west end. At St. John's, 5 deer were reported killed--2 inside the fenced corridor and 3 near the ends of the fenced segment.

Aerial deer counts in areas adjacent to the St. John's fenced corridor provided estimates of 90 deer each in the winters of 1977-1978 and 1978-1979, and 130 deer in 1979-1980. For Walnut Lake, the estimates were 130 deer in 1977-1978 and 110 deer in 1978-1979. No count was made at Walnut Lake in 1979-1980 due to insufficient snow for adequate counting; nevertheless the local conservation officer believed that there were more deer in the area than in the preceding winter.

Population modeling has also indicated changing deer populations in the antlerless quota areas containing the two fences; the number of deer increased about 40 percent from 1977 to 1979 in the Faribault County area and 15 percent in the Stearns County area. From 1977 to 1979, the number of deer killed by cars increased 56 percent in Faribault County (up 34 percent in the surrounding DNR region IV) but decreased 13 percent in Stearns County (up 17 percent in the surrounding DNR region III). Most of the 13 percent decrease in total number of deer killed by cars in Stearns County can probably be attributed to deer not hit at St. John's.

It was assumed that at least 20 deer per year, or 30 deer in the 18-month monitoring period, would have been killed in each of the Interstate segments if only the standard 1.2-m fences had been present. The 12 deer reported killed inside the Walnut Lake fence corridor and the 2 in St. John's thus represent a theoretical 60 and 93 percent reduction in deer-vehicle collisions, respectively (mean = 76.5 percent). This compares with an average 78.5 percent reduction for six such fences tested in Colorado (5).

Reasons for the difference in effectiveness of the two fences can be related to design differences. Two problems were apparent at Walnut Lake: (a) the segment of 2.4-m fence was too short and allowed the deer to enter the fenced corridor easily around the ends without having to deviate far from their normal travel routes, and (b) the fence was located in the lowest part of the road ditch and much of it stood in up to a meter of water most of the time. Thus, six (30 percent) of the gates at Walnut Lake never were usable by the deer, and because of the water in the ditch, deer tended to walk on the road shoulder when they crossed the fenced corridor.

We conclude that the fence at St. John's was effective in keeping deer off the highway. At Walnut Lake the inadequate length of the fence did not deny deer access to the highway, although it would have been difficult to lengthen the fence because there was an interchange at the west end where five of the deer were hit (four just inside the fenced corridor and one just outside). The location of the fence in the ditch precluded access to, or use of, a number of the gates once deer were in the highway corridor.

Cost-effectiveness of the fences and gates was evaluated by calculating benefit/cost ratios. The difficulty in such an exercise is in identifying and quantifying all benefits and costs (6). The major benefits include savings in vehicle repair costs and the value of deer not killed. We assumed that each collision prevented saved $503 in vehicle repair costs in 1978 (7). This value was multiplied by the estimated 18 fewer collisions annually at St. John's and 8 at Walnut Lake. The values were then adjusted for inflation by compounding annually (8) to estimate the average damage prevented in each of the next 20 yr. (The assumed rate of inflation was 9.028 percent, which is the average annual change in the price of motor vehicle parts from 1967 to 1981, inclusive, according to the producer prices and price indexes of the Bureau of Labor Statistics, U.S. Department of Labor.

Again following Lundgren (8), the inflated future benefits were individually discounted from year i to 1978. Discounting is used to reflect society's preference to have future monies (benefits) available earlier or to reflect what would be earned by an alternative investment. The assumed interest rate was 13.5 percent, which is the real rate of growth in the gross national product plus the general rate of inflation for all products at the wholesale level, on the average, during 1967-1981, inclusive (9). The rate of 13.5 percent was chosen as being a logical measure of the long-term growth of capital.

The value of a deer has been estimated at $709 by Norman (10) and $844 by Hartman (11), based solely on hunter expenditures. Leitch (12) estimated hunter expenditures at $270 per deer in 1974 with a meat value of $60. Hunter expenditures vary considerably due to hunting season length, harvest success rate, the proportion of nonlocal hunters, the perceived need for hunting equipment, and so forth. Hunter expenditures by themselves would not be so valid an estimator as the much larger capitalized value needed to produce the annual returns. We chose $500 as the value of a deer in 1978 and treated this estimate as we did the repair costs. (The annual inflation rate used for deer values was 7.284 percent, based on the change in the producer price index for toys, sporting goods, firearms, and ammunition, 1967-1981.)

The sum of inflated and discounted annual benefits was then divided by the incremental fence construction costs in 1978 of $66,000 at St. John's and $85,000 at Walnut Lake. The incremental cost, the cost of a 2.4-m fence plus gates beyond that of a standard 1.2-m fence, was used because the standard fence would have been installed anyway and it would not keep deer off the highway.

The resulting benefit/cost (B/C) ratios were 3.61 for St. John's alone, 1.24 for Walnut Lake alone, and 2.28 combined. We conclude that the fences are a cost-effective means of reducing deer-vehicle collisions in this situation. Because of design problems at Walnut Lake, we believe that the ratio for St. John's alone is the best estimator.

Extension of the economic analysis must be approached with caution because the input data would be different in other locations. Also, we do not know how reliable (variable) our estimate may be because we do not have any replication. Further, not all considerations were, or can be, reflected in the economic analysis. Factors not considered that would have lowered the B/C ratio include fence maintenance costs and allowance for self-repair of some vehicles after collisions with deer. Fence maintenance costs are not expected to be high, however, especially for the early years of the fence. Self-repair of vehicles appears most likely in cases where the deer are not severely damaged and may wander off or be taken by motorists before investigation; in neither case would a car kill likely be recorded under this system. Factors that would have increased the B/C ratio include probable traffic increases (both over the years and due to the attraction of highway traffic to the Interstates), future growth in the local deer herd, and the time and inconvenience on the part of public and private entities in handling collisions and the dead deer. On balance, the economic analysis is believed to be a fair but conservative evaluation of the effectiveness of the fences.

The only observed adverse effect of the fence was that two deer trapped against the outside of the fence at Walnut Lake were killed by dogs. This is a problem best solved by proper dog control. No adverse comments from the public were heard, and it was concluded that public acceptance of the fences was high. Hikers, skiers, hunters, woodcutters, and other pedestrians made considerable use of the gates, and there was some damage by cows and falling trees. Adequate attention must be paid to keeping the gates in proper working order to prevent deer from entering the highway corridor through the gates.

In conclusion, fence and gate design used at St. John's with an estimated 93 percent reduction in deer kills and B/C ratio of 3.61 was a successful and cost-effective method of reducing deer kills. If any such fences are built in the future, the design of the St. John's project should be followed; i.e., the fence should be located at the top of the backslope and be long enough to extend well beyond the area of normal deer movements. If this cannot be done, the fence will probably be ineffective. However, more thought should be given to routing new highways to avoid areas of high deer concentrations. Fences such as those tested must be considered a site-specific potential solution to reducing deer-vehicle collisions.

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