Management of Highway Right-of-Way for Waterfowl in North Dakota

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Waterfowl nesting was studied on 1.6-km (1-mile) blocks of land along the I-94 right-of-way in North Dakota. Alternate 1.6-km blocks were maintained in an early successional stage by annual fall mowing; the other blocks, which represented later successional stages, were left unmowed. Initial investigations revealed higher densities of duck nests and higher nest success in unmowed than in mowed right-of-way areas. No change was found in nesting preference in the unmowed areas from 1969 to 1972 as the vegetation aged, but patterns of nest success in the two types of areas over the 4-year period were significantly different. Nest success in unmowed blocks is shown to have declined between 1969 and 1972. Recommendations are presented for ensuring maximum waterfowl production along I-94.

The history of the loss of waterfowl habitat in the United States was recently documented by a task force of the U.S. Department of the Interior (1); such loss is the result of intensified land use, including drainage of wetlands. To mitigate this destruction, much time, money, and effort have gone into preserving and enhancing remaining wildlife habitat through the acquisition of federal wildlife refuges and state game management areas. There are, however, other large parcels of potential wildlife habitat that are publicly owned. These include the right-of-way lands associated with the nation's roads, highways, railroads, utility lines, pipelines, and water diversion ditches.

In 1957, national right-of-way lands were estimated to amount to 20 million hm^2 (50 million acres) (2). A recent forecast by the U.S. Environmental Protection Agency predicts that increasing demands "between now and the year 2000 will call for the duplication of everything built in the entire history of the U.S.—schools, pipelines, highways, airports, etc." (3) and thus lead to increased amounts of right-of-way.

Highways claim a substantial portion of right-of-way lands. When the National System of Interstate and Defense Highways is complete, more than 400 000 hm^2 (1 million acres) will be added to an existing 1 million hm^2 (2.5 million acres) of roadside area (4). Of course, not all of this may be of value to wildlife. The Interstate highway system crosses a vast number of different types of habitat. In the majority of cases, the true wildlife value of these narrow strips of land is unknown. Within the north-central states, however, many general nest studies have indicated intensive use of rights-of-way by game birds (5). A conservative estimate of the current size of the right-of-way area associated with just the Interstate systems of the north-central states is nearly 69 000 hm^2 (170 000 acres); this will approach 87 000 hm^2 (214 000 acres) when the system is complete. Primary and secondary highway rights-of-way encompass much more; in North Dakota alone these rights-of-way constitute 319 000 hm^2 (789 000 acres) (6).

The primary purpose of the North Dakota State Highway Department (NDSHD) is "the construction and maintenance of highways for the traveling public." Maintenance procedures for rights-of-way consist principally of mowing, spraying herbicides, and haying; in a few cases the vegetation is allowed to grow undisturbed. Governing these procedures are principles of safety and beautification. The best total management scheme should allow for and be compatible with all of the factors involved, including those that relate to wildlife.

Oetting and Cassel (5) have shown that, by using a nonmowing management plan, vegetation along a section of the I-94 right-of-way in North Dakota could provide attractive, secure nesting cover for waterfowl without altering highway safety considerations. In 1969 and 1970, Oetting and Cassel (5) found higher densities of duck nests and higher nest success in unmowed than in mowed right-of-way areas. Vegetation, however, is dynamic and characterized by constant change (7). Vegetation on idle land goes through a series of successional stages, some of which may not be consistent with the highway department's management goals. Miller (8) reported that waterfowl nest success was significantly greater in plots of land that lay idle for 4 years or less than in plots of land that lay idle for 5 years or more. Thus, idle land may become less productive for waterfowl populations in addition to becoming less acceptable to the traveling public.

Field investigations to compare location of waterfowl nests and nesting success on mowed and unmowed highway rights-of-way during a 4-year period from 1969 to 1972 continued through 1973. A second objective, which assumed uniformity in vegetation (the result of uniform seeding and maintenance procedures before experimental treatment), was to determine the effect of 3 years of nonmowing on the vegetation by comparing several vegetative characteristics of the mowed and unmowed blocks in 1971. To further test the response of waterfowl to early and later successional stages of vegetation, NDSHD allowed the entire study area to remain unmowed in the fall of 1972.

STUDY AREA

The study area, located in west-central Stutsman County, North Dakota, consisted of 37 km (23 miles) of right-of-way [248 hm^2 (614 acres)] on both sides of I-94 from the Oswego interchange to the Northern Pacific Railroad overpass east of Crystal Springs.

The right-of-way was seeded in 1959 with a mixture of 40 percent smooth bromegrass (Bromus inermis), 20 percent slender wheatgrass (Agropyron trachycaulum), and 40 percent crested wheatgrass (A. desertorum) (9). Smooth bromegrass currently dominates most of the right-of-way whereas crested wheatgrass is prominent on drier slopes. Volunteer yellow sweet clover (Melilotus officinalis) and alfalfa (Medicago sativa) are quite prominent on the inslopes. Many native and introduced forbs exist in the study area; shrubs and other woody vegetation are infrequent.

MATERIALS AND METHODS

In the fall of 1968, a 4-year agreement with the North Dakota State Highway Department allowed alternate 1.6-km (1-mile) blocks of the study area to remain unmowed (Figure 1). This treatment resulted in 23 mowed blocks [123 hm^2 (304 acres)] and 23 unmowed blocks [125 hm^2 (310 acres)]. Mowing was conducted once each year, in the fall, as a haying operation; the vegetation was cut, baled, and removed from the area. The response of waterfowl to these treatments was measured the fol-

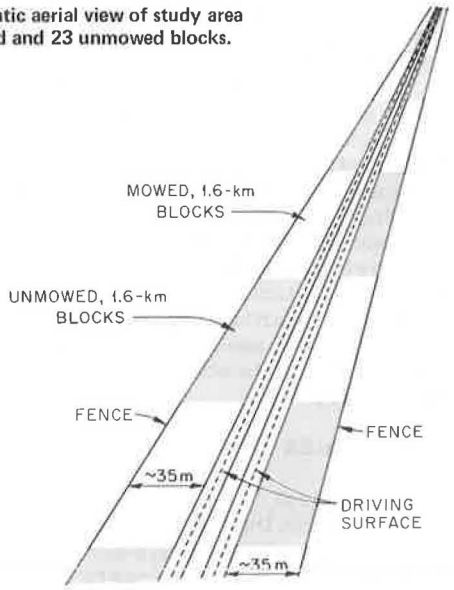
lowing nesting season. A second, 5-year agreement with NDSHD, which began in 1972, allowed for the entire study area to remain unmowed.

Between mid-May and the end of June each year, the study area was searched with a cable-chain drag (10) for nests of game birds. To be counted, a nest had to contain at least one egg. The stage of incubation was determined by use of a field candler (11) or the flotation method (12). Nests were revisited on or shortly after calculated hatch dates to determine the fate of the nest and the number of eggs hatched. A successful nest was one in which at least one egg hatched. Bird and animal predation was determined by examining nest and egg damage (13).

The right-of-way vegetation was surveyed in July and August 1971. Twenty-four sampling sites were systematically selected, six each in the mowed north, mowed south, unmowed north, and unmowed south. Data collected included total foliar cover (expressed as a percentage of the total ground surface), relative importance of each species (expressed as a percentage of the total foliar cover), frequency of occurrence for bare soil and litter by use of a point-frame apparatus (14), and height of vegetation. A composition list of species was also prepared for each sampling site. Surface areas of all wetlands within 1.6 km (1 mile) north and south of the I-94 study area were measured by means of standard aerial photographs [6.4 cm/km (4 in/mile)] from the Soil Conservation Service.

All data were keypunched on standard 80-column IBM cards, verified, and analyzed on an IBM 360/50 computer at North Dakota State University. The specific statistical tests performed on each set of data are given with the results. A complete discussion of the statistical analyses is given by Voorhees (15).

Figure 1. Diagrammatic aerial view of study area comprising 23 mowed and 23 unmowed blocks.



RESULTS

Nesting Activity

During the nest searches made between 1968 and 1973 [including data from Oetting and Cassel (5)], 709 bird nests were located; 671 were waterfowl nests (Table 1). Waterfowl nesting on the right-of-way in order of abundance was as follows:

Species	Number of Nests
Blue-winged teal (Anas discors)	284
Mallard (A. platyrhynchos)	153
Gadwall (A. strepera)	127
Northern shoveler (Spatula clypeata)	53
Pintail (A. acuta)	51
Lesser scaup (Aythya affinis)	3

During six nesting seasons (1968 to 1973), waterfowl nest initiation began during the third week of April and reached a peak during the third week of May; only four nests were started after the first week of July. Hatching began during the third week of May, reached a peak during the third week of June, and by approximately the second week of August all nests were terminated. Chronology of nest initiation by species showed a typical pattern: Mallards and pintails were the earliest nesters followed by northern shovelers, blue-winged teal, and gadwalls.

Nest Location

The number of nests located in the mowed and unmowed blocks from 1969 to 1972 is shown in Figure 2. More ducks chose unmowed vegetation in preference to mowed

Table 1. Waterfowl species and success of nests along I-94 (1968 to 1973).

Species	Number of Nests	Successful Nests[a]		Number of Unsuccessful Nests by Cause of Failure				
		Number	Percent[b]	Predation by Mammals	Normal Desertion	Desertion Caused by Search	Fate Unknown	Miscellaneous[c]
Ducks								
Mallard	153	67	47.2	71	3	8	0	4
Pintail	51	27	55.1	22	0	2	0	0
Gadwall	127	63	55.8	47	2	8	2	5
Blue-winged teal	284	142	54.6	106	6	12	5	13
Northern shoveler	53	27	55.1	21	0	4	0	1
Lesser scaup	3	2	66.7	0	1	0	0	0
Subtotal	671	328	53.3	267	12	34	7	23
Upland sandpiper	22	19	90.5	2	0	0	1	0
Hungarian partridge	3	1	100.0	0	0	2	0	0
Mourning dove	9	6	85.7	1	0	0	2	0
Killdeer	3	3	100.0	0	0	0	0	0
American bittern	1	1	100.0	0	0	0	0	0
Total	709	358	55.2	270	12	36	10	23

[a] Nests crushed or deserted because of the search and nests of unknown fate are not included in success ratios because they had no chance for success.
[b] Calculated by dividing the number of successful nests by the number of nests that had a chance for success.
[c] Includes 8 nests destroyed by predatory birds, 14 destroyed by searching, and 1 washed away by rain.

vegetation each year, and the ratios of the numbers of nests for the two vegetation types were nearly equal over the 4-year period ($P > 0.01$). During all 4 years, the preference for unmowed vegetation was highly significant ($P < 0.001$).

Mallard ($P < 0.001$), pintail ($P < 0.001$), and gadwall ($P < 0.001$) showed the greatest response to unmowed vegetation. The numbers of blue-winged teal and northern shoveler nests were nearly equal in mowed and unmowed blocks over the 4-year period.

In 1973, when the entire study area was unmowed, 49 duck nests were located in previously mowed blocks and 50 in previously unmowed blocks.

Nest Success

Nest success from 1968 to 1973 was 55.2 percent for all nests and 53.3 percent for duck nests. Except for lesser scaup (only three nests), nest success was nearly equal for all waterfowl species (Table 1). Mallards had the lowest success (47.2 percent) and gadwalls the highest (55.8 percent). Mammalian predators, primarily the striped skunk (Mephitis mephitis) and red fox (Vulpes vulpes), destroyed 267 waterfowl nests, or 93 percent of all nests destroyed.

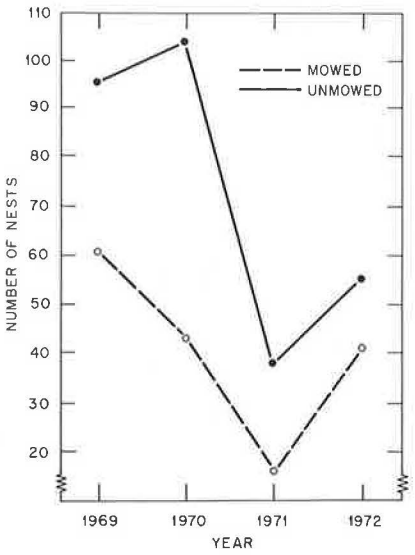


Figure 2. Number of nests located in mowed and unmowed blocks from 1969 through 1972.

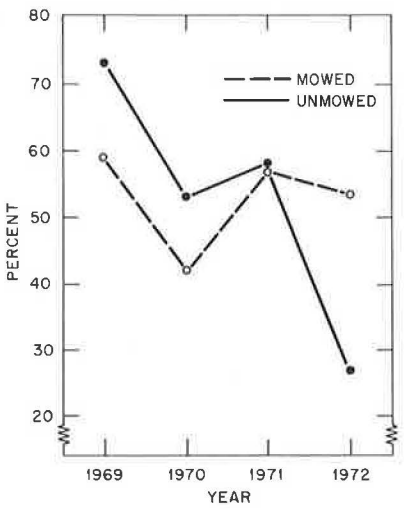


Figure 3. Nest success in mowed and unmowed blocks from 1969 through 1972.

Hatching success is shown in Figure 3. (The percentage of success was calculated by dividing the number of successful nests by the number of nests that had a chance for success.) The pattern of success in the mowed blocks over the 4-year period differed from that in the unmowed blocks ($P < 0.01$). Nest success in the mowed blocks was not significantly different over the 4-year period ($P > 0.10$), whereas in the unmowed blocks nest success was significantly dependent on the year ($P < 0.001$). Success in unmowed vegetation continually declined from 1969 to 1972 compared with nest success in mowed vegetation.

The number of nests destroyed by mammals in mowed blocks did not vary from 1969 to 1972 ($P > 0.10$), whereas destruction by mammals in unmowed blocks changed markedly from year to year ($P < 0.001$). Predation by mammals in unmowed vegetation continually increased over the 4-year period compared with predation in mowed blocks.

In 1973, when the entire study area was unmowed, nest success was nearly equal in the previously mowed and unmowed blocks—45 and 48 percent respectively.

Vegetation

A total of 85 plant species were identified within the sampling areas: 71 in mowed and 68 in unmowed blocks (15). Fifty-four species were common to both areas. The number of species found in the mowed sampling sites ranged from 12 to 39 and averaged 23; comparable figures for the unmowed sites ranged from 23 to 43 and averaged 31. Only 13 species were common to more than half of the mowed sites, whereas 25 species were common to more than half of the unmowed sites. Wild prairie rose (Rosa arkansana), a shrub, occurred more frequently in unmowed sites (50 percent) than in mowed (25 percent) sampling sites ($P < 0.20$). Buckbrush (Symphoricarpos occidentalis), another woody species, also occurred more frequently in unmowed sites (42 percent) than in mowed sites (8 percent) ($P < 0.04$).

Based on foliar cover, the dominant species in both mowed and unmowed blocks was smooth bromegrass (55 and 61 percent respectively); crested wheatgrass ranked second in each area (20 and 14 percent respectively). Other principal species present in each area were Kentucky bluegrass (Poa pratensis), yellow sweet clover, alfalfa, and quackgrass (Agropyron repens).

Total foliar cover was greater ($P < 0.001$) in the unmowed blocks (52 percent) than in the mowed blocks (39 percent). Generally, the heights of each of the major species of vegetation in the unmowed blocks exceeded those in the mowed blocks ($P < 0.001$) by approximately 5 cm (2 in).

Bare soil occurred more frequently ($P < 0.001$) in the mowed blocks (21 percent) than in the unmowed blocks (2 percent). The reverse was found for litter; more litter ($P < 0.001$) occurred in the unmowed blocks (88 percent) than in the mowed blocks (65 percent).

Wetlands

The surface areas of wetlands adjacent to the mowed and unmowed blocks were nearly equal [13.9 and 13.3 hm^2/km^2 (89 and 85 acres/$mile^2$) respectively].

DISCUSSION OF RESULTS

This study clearly demonstrated that nesting waterfowl preferred to nest in the unmowed portions of the Interstate right-of-way. In comparison with the mowed blocks, however, total duck production in the unmowed

blocks (the number of eggs hatched) continually declined from 1969 to 1972. The data suggest that right-of-way vegetation that is allowed to remain completely undisturbed for a period of 3 or 4 years may not be of optimal value for the production of waterfowl.

Oetting and Cassel (5) found that problems that were expected to result from a cessation of mowing, such as increased collisions between wildlife and vehicles and snow buildup, did not materialize. The only additional change in vegetation caused by nonmowing that might affect the highway department's management goals is the increase in the occurrence of woody plant species. Because such species remain erect throughout the winter, they might eventually cause increased snow buildup on the driving surface of the highway. Currently, however, even though the frequency of occurrence of woody species has been greater in the unmowed areas, the actual number of plants is quite low (15).

The fact that nesting puddle ducks (Anatinae) generally prefer ungrazed and unmowed vegetation is well documented (16, 17, 18, 19). For each year of this study, more ducks chose unmowed than mowed vegetation. There was no difference in the distribution of waterfowl nests between mowed and unmowed blocks over the 4-year period, which suggests that the preference for unmowed blocks did not change as the vegetation became older.

The presence of open water is a prime factor in the distribution of waterfowl and their use of habitat (20). Therefore, the preference for unmowed blocks could have been influenced by the distribution of water in the area. However, surface areas of wetlands adjacent to the mowed and unmowed blocks were nearly equal. In 1968, when the entire study area was mowed, there were 59 nests in areas designated to be mowed and 61 in blocks designated to be unmowed (5). In 1973, when the entire study area was unmowed, the distribution of waterfowl nests between blocks that were previously mowed and blocks that were previously unmowed was again nearly equal—49 and 50 nests respectively. This suggests that nesting waterfowl were responding primarily to the vegetation and not to the adjacent land use (including the distribution of water). Vegetation parameters that most influence nesting waterfowl are total foliar cover and litter (15).

Nesting waterfowl can be attracted to undisturbed habitat but, unless a high percentage of these nests hatch, the result is still low production. This study demonstrated that as land was left idle the success of duck nests declined. The decline in nest success in unmowed blocks was attributed to predation by mammals. The reason for increased predation in the unmowed blocks is not completely understood and can only be speculated on at this time (15).

Hammond (21) stated that waterfowl production is the result of so many interwoven factors that isolation of one is almost impossible. When the results of nesting studies are compared, the task is even more difficult. Recently, however, several investigators (8, 22, 23, 24, 25, 26) have recognized an important factor in waterfowl production: the age of the vegetation. Their results and ours indicate that vegetation should be in early stages of succession for optimal waterfowl production.

RECOMMENDATIONS

The North Dakota State Highway Department should continue to follow the management recommendations offered by Oetting and Cassel (5):

(1) ditch bottoms, secondary slopes, and back slopes should remain unmowed and inslope mowing for reduced snow hazard should be minimal, (2) interchange triangles should remain unmowed except to the toe of the inslope or less, and (3) mowing of inslopes should be delayed until well after the peak of waterfowl nesting–at least until July 20.

For optimal waterfowl production along I-94, however, the vegetation should be kept in an early stage of succession by rotational mowing at 3-year intervals. The vegetation should be cut, baled, and removed from the area. To maintain some residual cover along the east-west continuum of the right-of-way, only one side should be mowed at a time. Rotational mowing should not only produce the most waterfowl but also control the growth of woody species.

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Five-Year Evaluation of Highway Mowing Practices in Indiana

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A 5-year evaluation of roadside mowing practices in Indiana was completed in 1976. Findings show that the first mowing cycle is the most critical. This mowing is wasted if done too early because the most rapid growth of grass occurs in early spring. If it is carried out too late or when the grass is wet, injury to the turf may result from piling up of grass and smothering. The optimum height for the first mowing cycle is between 46 and 61 cm (18 and 24 in). To prevent scalping and to avoid piling up and smothering of grass, the grass should be mowed to a height of at least 13 to 15 cm (5 to 6 in). The second cycle of three-cycle mowing is less critical and could be eliminated most seasons if the first cycle were delayed. The last cycle should be delayed so that no more than about 30 cm (12 in) of growth occurs before winter. This leaves the roads with a well-maintained appearance during the winter months and with enough growth to protect the grass from winter killing but not so much growth as to interfere with either fall or spring spraying for control of broadleaf weeds. Unmowed roadsides remained in good condition over the 5-year observation period when combined with the fall-spring spraying rotation for control of broadleaf weeds. A major problem was that brush began to take over in some areas. Addition of a brush-control agent (a three-way herbicide mixture of 2,4-D, dicamba, and Silvex) to the fall-spring spraying rotation for these areas or one-cycle mowing at least every other year is indicated.

Rising costs of roadside maintenance, with respect to mowing operations and the national interest in conserving energy and fossil fuel, make it imperative to consider alternatives to multiple-cycle mowing as a solution to maintenance of turfed roadsides. Two possibilities are currently available: (a) reduced mechanical mowing and (b) chemical mowing by spraying retardants of grass growth. This paper deals with the first of these options.

Conservative estimates of the areas from the outside of the shoulders to the farthest boundary of the right-of-way subject to some type of vegetation management yield figures that suggest that approximately 30 000 hm^2 (75 000 acres) of roadside in Indiana are presently included in some phase of a contract spraying or mowing program. On a typical Interstate route, 1.6 km (1 mile) may have more than 8 hm^2 (20 acres) to maintain. Since the cost of roadside mowing normally exceeds \$62.50/hm^2 (\$25/acre) each season, even when effective weed control reduces mowing, the potential magnitude of cost savings in roadside mowing is considerable.

In 1970, the Indiana State Highway Department reduced its five-cycle contract mowing program to reduce costs and to conserve energy. The reduction in the number of mowings was possible in large measure because of effective weed control through the fall-spring contract spraying program (1).

In 1972, studies were initiated to evaluate these reduced mowing practices. The objectives of the study were to

1. Identify unnecessary mowing cycles so that such cycles might be eliminated,
2. Schedule those mowing cycles that provide the