Survey of Landscape Use of Native Vegetation on Midwest Highway Rights-of-Way

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The transportation departments of 14 Midwestern states that occupy the region of the tallgrass prairie were surveyed on the management and use of prairie species on highway rights-of-way (ROW). A total of 128 surveys was mailed to state and district division offices; the response rate was 70 percent. The survey was divided into two sections: the first on the extent that prairie and other native vegetation are used on ROW and how well prairie meets the requirements of vegetation for ROW landscaping, the second on the establishment and management techniques used by highway departments and problems associated with these techniques. Ten of the 14 states are involved in the establishment of prairie vegetation; the remaining 4 are active in managing prairie on portions of roadsides. All states plant native grasses, wildflowers, and trees, as well as wildflower mixes of native and exotic plants. Drilling was rated higher in satisfaction and success than no-till seeding, hydroseeding, and transplanting. Four states reported the use of fire as a roadside management tool. Respondents reported that information on the management of prairie was inadequate and that department research on the topic was not widely disseminated.

This study of the use of native vegetation on rights-of-way (ROW) began after the Wisconsin Department of Transportation (DOT) initiated planting of native grasses, wildflowers, and trees for 42 mi of a newly reconstructed highway in the central sand plains of that state. The landscape goal was to create a corridor containing facsimiles of some of the plant communities that would have occurred in the area at the time of European settlement. Those communities were (a) prairie, a community dominated by grasses and largely devoid of trees, and (b) oak savanna, is a grassland community with a canopy cover of less than 50 percent (*1*). Searches for information on prairie establishment and management found relatively abundant material on natural plantings in arboreta and institutional grounds, but this information is not necessarily applicable to the planting of prairie on highway ROW because of the unique environmental characteristics and functional needs of the corridors. Highway departments that had tried prairie plantings, however, have published little information on the details of the planting process or on the extent and success of these plantings. The survey was an attempt to gain a better understanding of the use of prairie along roads and highways.

On the basis of discussions with transportation personnel and recent conference topics on the subject, it appears that interest in native plantings is increasing, but the levels of experience with native plants and the reasons for the interest in them vary. Many individuals appear to view native plantings as a low-cost alternative to turf grasses, whereas others view them as an aesthetic or ecological approach to ROW planning.

The use of prairie, native grasses, and wildflowers on roadsides, however, is not new. As early as the 1920s, Texas was experimenting on a small scale with wildflowers on roadsides. During the 1960s, Texas advocated the planting of wildflowers as a tool to encourage tourism. Nebraska, along with other states on the western fringe of the tallgrass prairie, has experimented for several decades with planting native grasses and wildflowers—partially for their beauty but with strong interest in their erosion controlling capabilities, water conservation properties, and abilities to increase soil fertility (*2*). Michigan began a program called Operation Wildflower in 1975 to promote the planting and establishment of roadside wildflowers. Prairie plantings have also been established along a number of expressways in the Chicago area. Both Minnesota and Wisconsin have established committees to review current landscape and roadside vegetation policies. *Roads and Bridges*, *Wildflower*, and conference proceedings, including the North American Prairie Conferences, National Roadside Vegetation Managers Association meetings, and Environmental Concern for Right-of-Way Management, have included articles or special issues examining the use of native plantings on roadsides as a means to ease management costs and enhance aesthetics. A paper on planting prairie in ROW was published in a 1981 *Transportation Research Record* on vegetation management (*3*).

The potential value of prairie for roadside planting is due in part to its evolution under the Midwest's climate. The prairie is a product of the interaction of microclimate, topography, and soils (*4–6*). Tolerant of extreme temperatures, drought resistant, and adaptable to a wide range of soils and soil characteristics, the prairie appears to be suited to less hospitable roadside environments than many agronomic or ornamental groundcovers. The prairie is also long-lived and has a deep, fibrous root system that benefits the development of organic matter in soils and aids erosion control (*7*).

PURPOSE OF SURVEY

The survey described here was distributed in April 1988. The first half of the survey was designed to determine the extent to which state transportation agencies plant native vegetation,

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FIGURE 1 Tallgrass prairie and survey regions.

particularly prairie, and how well this vegetation meets the demands and requirements of roadsides. The following questions were addressed.

1. Which Midwestern state transportation departments and their districts plant prairie or other native plant forms?
2. Are there regional trends in the use of native plant materials on roadsides?
3. How well does prairie, in particular, meet the demands and requirements that planners and managers have for roadside vegetation?

The second half of the survey was used to examine prairie establishment and management techniques used by transportation departments and their success. The following three main questions were addressed.

4. What techniques are used by transportation departments to plant prairie? How successful are they?
5. How are prairie plantings on ROW managed? Which techniques have been successful?
6. Is knowledge on prairie installation and management sufficient?

METHODS

A predominantly closed-ended questionnaire was mailed to state and district transportation offices in April 1988. Respondents were asked to rate or rank variables for 134 of the 170 questions. The remaining questions were either multiple choice or open-ended. Respondents were asked to include comments with their responses.

The sample was confined to 14 states in the original range of tallgrass prairie (Figure 1). This area extends from the Canadian border into Texas and from Ohio to the eastern third of North Dakota. Iowa is the only state that resides completely in the original tallgrass prairie range.

All surveys (n = 128) were addressed to state and district highway employees in charge of plantings and roadside maintenance. Employees were selected randomly from lists acquired previously from state offices. Comparisons between responses of state and district employees showed no significant differences; therefore, all responses were grouped together for analysis. Administration of the survey followed work by Dillman (*8*). Postcards containing a survey reminder and thank you were sent to all addresses one week after the original survey was sent. Those who did not respond were sent a letter three weeks later that stressed the importance of their participation in the survey. After another three weeks, they received a new survey form and a letter.

Landscape architects represented 42 percent of the respondents, engineers 23 percent, and specialists, including foresters and agronomists, 20 percent. A catch-all category for maintenance personnel represented an additional 15 percent. The final response rate was 70 percent (n = 90). Some states returned only one survey from a central office, claiming that it represented policies and actions followed by all department employees.

Questions were analyzed by tabulating responses and calculating frequencies. Not all questions were applicable to all respondents. For instance, some questions were to be answered by participants of a defined group (e.g., those who have planted prairie). Therefore, the number of responses to each question varied.

Written comments were provided by 74 percent of the respondents. These comments are reported when appropriate. However, comment summaries do not necessarily represent an unbiased or representative sample of roadside personnel, and in most cases, are based on the views of a few individuals.

The definition of a prairie was given to survey respondents—native tallgrass, mixedgrass, and shortgrass landscapes that were once common in the Midwest and Plains States. Prairie was considered to be the simultaneous planting of forbs and grasses. It is assumed that no department is actually restoring prairie in the sense of a scientific community. Questions were also asked about separate plantings of native grasses and forbs.

RESULTS

Which Midwestern DOTs Plant Prairie or Other Native Plant Forms?

Despite whether a respondent was actively engaged in using native plantings (prairie, native grasses, native wildflowers, wetland plants, or native trees and shrubs), respondents in all states liked the idea of using native vegetation on roadsides. Ten states—Illinois, Indiana, Iowa, Michigan, Missouri, Minnesota, North Dakota, Ohio, Texas, and Wisconsin—are planting prairie as part of their roadside landscape program.

Although prairie plantings have been conducted by states for the past 20 years, the most planting has occurred during the past 8 years. Many respondents were engaged in planting and experimenting with prairie plants but remarked that they lacked sufficient time and experience to judge their effectiveness and that of other native materials. Most of these plantings occur along limited access highways, primary highways, and in rural areas. Less than one-third of the respondents reported having prairie plantings in urban and suburban areas.

Plantings of native trees and shrubs, grasses, and wildflowers have been conducted by the vast majority of respondents in all surveyed states (Table 1). Respondents have been highly satisfied with plantings of native trees and shrubs and grasses and moderately satisfied with native wildflowers (Table 2).

TABLE 1 RESPONDENTS INVOLVED WITH PLANTING NATURAL VEGETATION ON ROW

STATE	N=	PRAIRIE	NATIVE GRASSES	NATIVE WILDFLOWERS	WILDFLOWER MIXES	NATIVE TREES
ILLINOIS	8	7	8	7	4	8
INDIANA	6	3	3	4	4	3
IOWA	5	4	5	5	2	4
KANSAS	2	0	2	2	1	2
MICHIGAN	7	4	6	7	3	6
MINNESOTA	14	11	12	13	4	14
MISSOURI	2	2	2	2	1	2
NEBRASKA	1	0	1	1	1	1
NORTH DAKOTA	4	2	4	2	0	4
OHIO	8	5	6	8	7	8
OKLAHOMA	1	0	1	1	1	0
SOUTH DAKOTA	3	0	2	2	0	3
TEXAS	19	5	17	18	11	18
WISCONSIN	5	4	4	5	1	5
TOTAL	85	47	73	77	40	78

Wildflower mixes, composed of native and exotic species and developed for broad regions of the country, are used frequently by some states (Indiana, Ohio, Oklahoma, and Texas) and infrequently by others. Although both wildflower and wildflower mixes have widespread support, nearly 24 percent of the respondents were dissatisfied with them. Weeds were viewed as highly competitive with wildflowers, and wildflowers were perceived as requiring much "tender loving care" in their establishment. Therefore, they were considered costly to establish and maintain, and for some, "a lot of fuss and bother for the short term."

Less than one-third of the respondents are engaged in wetland plantings; however, the variation between states planting wetlands is great. Two-thirds or more of the respondents from Wisconsin, Illinois, Michigan, and South Dakota reported attempts at wetland establishment. Less than one-quarter of the respondents from Minnesota, Texas, Ohio, Oklahoma, and Indiana reported establishing wetlands on roadsides. Wetland plantings had the greatest dissatisfaction (29 percent) of any planting type.

Do Regional Trends Occur in Use of Native Plant Materials?

Survey data were also tabulated by grouping respondents and states into regions because geographic location was expected to significantly influence a response. Region 1 consisted of

TABLE 2 PERCENT OF RESPONDENTS SATISFIED WITH NATURAL PLANTINGS

VEGETATION TYPE	N=	VERY SATISFIED	SOMEWHAT SATISFIED	SOMEWHAT DISSATISFIED	VERY DISSATISFIED
PRAIRIE	58	32.8	51.7	12.1	3.4
NATIVE GRASSES	76	46.1	43.4	10.5	0.0
NATIVE WILDFLOWERS	77	40.3	36.4	16.9	6.5
WILDFLOWER MIXES	47	27.7	51.1	21.3	2.1
WETLAND	34	14.7	58.8	26.5	2.9
NATIVE TREES	78	47.4	46.2	5.3	1.3

the northern and central tallgrass prairie states of Minnesota, Wisconsin, Illinois, Iowa, and Missouri (Figure 1). Region 2 consisted of Ohio, Indiana, and Michigan, which lie along the eastern edge of the prairie peninsula where prairie is found in pockets interspersed among hardwood forests. Oklahoma, Kansas, Nebraska, South Dakota, and North Dakota constituted Region 3, an area that includes the transition area from tallgrass prairie to mixed and shortgrass prairie. Region 3 has a significant amount of open land that is devoid of trees and still contains substantial acres of grasslands. Region 4 consisted of a single state, Texas, into which the southern edge of the tallgrass prairie extends. The number of respondents from each area are as follows: Region 1, $n = 36$; Region 2, $n = 21$; Region 3, $n = 11$; and Region 4, $n = 21$.

The majority of prairie planting attempts would appear to be occurring in the north central and eastern zones of the survey area. Illinois, Wisconsin, Iowa, and Minnesota of Region 1 had the greatest percent of respondents who reported that their departments have planted prairie (Table 3). In Region 2, nearly two-thirds of the respondents reported prairie plantings, whereas in Region 3, 20 percent reported planting prairie vegetation. South Dakota, Oklahoma, Kansas, and Nebraska of Region 3 each reported that they were not establishing prairie on roadsides, although prairie species were planted in rest areas in some states. Each of these states, however, manages naturally occurring prairie on roadsides and reported that they are active in planting large areas of native grasses. Approximately one-fourth of the respondents in Region 4 at the southern border of the tallgrass prairie reported conducting prairie plantings; others reported that they considered themselves outside the tallgrass prairie region.

All regions plant native trees, shrubs, grasses, and native wildflowers. A distinct difference between the percent of respondents planting wildflowers and wildflower mixes occurred in both regions 1 and 3, where 41 percent and 30 percent of the respondents plant wildflower mixes, and 94 percent and 73 percent plant native wildflowers, respectively. Species origin and stability are major differences between the plants composing these two types of wildflowers. Native wildflowers are local to the area of planting, and plantings often become dominated with perennials. Mixes are composed for broad regions, and not all species included are adapted to any one locale. Many of the species included in the mixes are annuals or biennials and therefore are present for only one to two years.

One aspect of measuring the perceived value of a vegetation type is how willing one is to go out of the way to preserve and manage it. As prairie has been removed from the landscape, the restoration and preservation of the remnants that are left has become an important issue in the scientific community. Some of these remnants may occur on roadsides as original prairie patches; more likely they have recolonized the right-of-way after road construction.

Two-thirds of the respondents stated that they were involved in preserving prairie remnants, most with citizen groups. Slightly more than half of the respondents reported that management plans or practices were developed to protect endangered species and remnant native vegetation located in ROW.

However, nearly two-thirds of the respondents also reported that their departments seldom kept records on remnant locations or compiled lists of species within these remnants. One might expect then that the majority of remnants and endangered species on roadsides are unknown to most departmental personnel and therefore receive no special treatment.

Responses vary considerably among regions. Regions 1 and 2 keep records on locations of native vegetation remnants "always" to "most of the time." Twenty-five percent of the respondents in Region 3 keep records "most of the time," and less than ten percent in Region 4 do. No regions regularly keep species lists at remnant sites.

How Well Does Prairie Meet the Demands of Planners and Managers?

The use of different vegetation types in a landscape setting depends on how well a planner perceives that the vegetation type will function in meeting the site's goals and objectives. Therefore, if any native vegetation is to become a common element along roads it must be perceived as being capable of meeting common ROW landscape objectives. Snow (*9*), for example, listed the following functions of plants along highways: (a) control erosion, (b) lower maintenance costs, (c) provide aesthetic beauty, (d) control snow drifting, (e) reduce headlight glare, (f) reinforce road alignment, and (g) serve as crash barriers. To determine how respondents per-

TABLE 3 PERCENT OF RESPONDENTS IN GEOGRAPHIC REGIONS THAT ARE PLANTING NATIVE VEGETATION ON ROW

REGION	N=	PRAIRIE	NATIVE GRASSES	NATIVE WILDFLOWERS	WILDFLOWER MIXES	WETLANDS	NATIVE TREES
1	34	82.4	94.1	94.1	40.6	37.5	97.1
2	21	60.0	71.4	90.5	70.0	23.8	81.0
3	11	20.0	90.9	72.7	30.0	30.0	87.5
4	21	26.3	89.5	95.0	57.9	94.4	95.0

ceived the function of vegetation in ROW and whether prairie meets their criteria, three questions were asked: (a) What are the responsibilities of roadside managers and planners? (b) What are the criteria used in selecting vegetation for landscape cover? and (c) Does prairie successfully meet these criteria and responsibilities?

Responsibilities of Roadside Managers and Planners

The primary responsibilities of roadside managers were perceived by the survey respondents to be weed control (99 percent), woody plant control (95.5 percent), maintenance of visual quality (94.5 percent), and erosion control (95.5 percent). Creation and maintenance of wildlife habitat (60 percent) and reduction of glare (62.9 percent) had less support as responsibilities, but even these were supported by more than one-half of the respondents. Management for wind and snow control was considered an important responsibility by 80 percent of the respondents.

Criteria Used in Selecting Vegetation for Landscape Cover

Ease in establishment received the highest score (Table 4) when respondents were asked to rank the top 10 criteria of a list of 22 that they would use to select plants. Rankings were summed for each criteria, and the relative percent that each was used in plant selection was computed. Seven of the top 10 criteria dealt with the ability of a species to establish and sustain itself in highway environments. Attractiveness, previous experience in dealing with a plant, and its response to mowing also ranked in the top 10. Respondents strongly agreed on the importance of the criteria, listing a total of only 12 of the 22 given criteria in the top 10. Respondents listed

TABLE 4 RELATIVE FREQUENCY OF AGREEMENT FOR ROW PLANT SELECTION CRITERIA BY RESPONDENTS ASSIGNED TO GEOGRAPHIC REGIONS

CRITERIA	REGION 1	REGION 2	REGION 3	REGION 4
ESTABLISHMENT EASE	14.23	10.93	14.95	13.84
ABILITY TO NATURALIZE	8.75	8.25	12.02	11.75
DROUGHT RESISTANT	8.70	10.70	8.63	11.38
IS A NATIVE SPECIES	10.47	6.58	9.86	12.48
ATTRACTIVE	10.06	9.48	9.40	9.38
DISEASE RESISTANT	9.54	10.47	7.40	9.11
PRIOR EXPERIENCE WITH SPECIES	8.34	4.91	3.38	5.28
TOLERANT OF POLLUTANTS/SALT	6.88	8.92	1.39	2.64
RESPONDS TO MOWING	2.29	4.79	6.16	5.10
RESPONDS TO CHEMICAL TREATMENT	2.39	5.46	2.77	5.28
COMPETES WELL	4.38	2.23	3.54	4.28
CREATES WILDLIFE HABITAT	3.13	1.23	7.24	0.82
WILL ACT AS SNOW FENCE	2.81	3.90	3.24	0.18
EVERGREEN	0.47	2.68	3.24	2.00
RECOMMENDED BY EXPERTS	1.88	1.90	1.54	2.00
LIMITED MATURE TRUNK DIAMETER	1.09	1.68	0.31	2.00
EFFECTIVE AS GLARE SCREEN	1.20	2.01	0.62	1.09
LIMITED MAXIMUM HEIGHT	1.20	2.56	0.00	0.00
DECIDUOUS	0.52	0.67	2.47	0.09
INVASIVE	0.05	0.00	1.08	1.37
USDA RECOMMENDATION	0.21	0.45	0.77	0.73

TABLE 5 PERCENT AGREEMENT FOR PRAIRIE PLANTING SELECTION CRITERIA

CRITERIA	HAVE PLANTED (N=38)			HAVE NOT PLANTED (N=19)		
	AGREE	UNSURE	DISAGREE	AGREE	UNSURE	DISAGREE
LESS COSTLY TO MAINTAIN	84.2	10.5	5.3	31.6	57.9	10.6
VISUALLY ATTRACTIVE	91.8	5.4	2.7	73.7	10.5	15.8
EFFECTIVE FOR EROSION CONTROL	71.0	23.7	5.3	63.2	36.8	0.0
PLANTED DUE TO PUBLIC RESPONSE	39.5	31.6	28.9	42.1	36.8	21.1
PART OF MITIGATION	37.8	24.3	37.8	31.6	52.6	15.8
REQUIRES LITTLE MOWING	94.8	5.3	0.0	73.7	21.1	5.3
REQUIRES LITTLE SPRAYING	84.2	7.9	7.9	57.9	36.8	5.3
COMPETES WELL	71.1	21.1	7.9	47.4	47.4	5.3
DROUGHT RESISTANT	94.6	5.4	0.0	79.0	21.1	0.0
GROWS IN LOW FERTILITY SOILS	73.7	18.4	7.9	52.6	42.1	5.3
INFO ON ESTABLISHMENT AVAILABLE	47.4	23.7	28.9	15.8	63.2	21.0
INFO ON MANAGEMENT AVAILABLE	39.4	26.3	34.2	10.6	63.2	26.3
SEEDS AND PLANTS AVAILABLE	42.1	13.2	44.7	10.6	42.1	47.3

additional criteria, two related to plant survival (tolerance to compacted soils and winter hardiness) and two practical ones (cost and availability of material) as concerns.

Ability of Prairie to Satisfy Plant Selection Criteria

The respondents were given 14 different criteria taken from the previous list and the literature (Tables 5 and 6) that are often cited as reasons for using prairie. Respondents were asked to rate the criteria using one of the following responses: strongly agree, agree, unsure, disagree, and strongly disagree. Respondents were also asked to compare prairie with vegetative covers of bluegrass and bromes on a number of similar criteria (Table 7).

Establishment Ease Respondents did not consider prairie an easy vegetation type to establish relative to traditional herbaceous plantings. They commented that prairie plants are

TABLE 6 ESTABLISHMENT EASE OF ROW PRAIRIE PLANTINGS

		% OF RESPONDENTS THAT FIND PRAIRIE ESTABLISHMENT:			
REGION	N=	QUITE EASY	SOMEWHAT EASY	SOMEWHAT DIFFICULT	EXTREMELY DIFFICULT
1	29	0.0	24.1	72.4	3.4
2	7	28.6	42.9	14.3	14.3
3	8	25.0	25.0	37.5	12.5
4	8	0.0	50.0	37.5	12.5
TOTAL	52	7.7	30.8	53.8	7.7

TABLE 7 COMPARISON OF PRAIRIE WITH BLUEGRASS AND BROME IN ROW PLANTINGS

		PERCENT RESPONDING THAT PRAIRIE IS:		
CRITERIA	N=	SUPERIOR	EQUAL	INFERIOR
EROSION CONTROL	33	24.2	57.6	18.2
LOWER MAINTENANCE COSTS	39	61.5	30.8	7.7
VISUAL ATTRACTIVENESS	44	59.1	31.8	9.1
PUBLIC APPEAL	30	33.3	42.4	20.0
LESS EQUIPMENT COSTS	36	44.4	47.2	8.3
LESS HERBICIDE APPLICATION	38	65.8	31.6	2.6
LESS MOWING	41	73.2	22.0	4.9
WITHSTANDS ROADSIDE POLLUTANTS	28	50.0	35.7	14.3

slow to germinate. Less than one-half of those who plant prairie believed that information on the establishment and management of prairie was readily available, and more than one-third believed it was not. Because of seed size and structure, many native grasses and wildflowers also require special planting equipment. Prairie establishment and management requires techniques that are different from those common to the more traditional cool-season turfgrass mixtures, and some techniques, such as burning, are considered inappropriate for highway settings.

Attractiveness Respondents agreed that attractiveness was important to landscaping and plant selections for ROW and that prairie was as attractive or more attractive than brome or bluegrass sods. Even so, only 40 percent of the respondents reported a large public demand to plant prairie.

Adaptability Nearly all respondents agreed that prairie was drought resistant. Past studies suggest that mature prairie plantings are capable of surviving and recovering after an extended drought but that newly planted prairies are not (*7*). The majority of respondents in each region also agreed that prairie grows well in low-fertility soils. Low fertility needs translate into cost savings in initial bed preparation and in less weed competition during establishment. Prairie species were not considered to have greater tolerance to salts or pollutants than brome or bluegrass sods, and research on this topic appears limited.

Maintenance Maintenance techniques and the timing of their applications vary between the cool-season plants of fescue and bluegrass and the warm-season plants of prairie. Respondents agreed that prairie requires less mowing and herbicide application than bluegrass or brome.

Ability to Compete Nearly two-thirds of respondents agreed that prairie competes well with established weeds. The dense rooting system of established prairies prohibits growth of late arrivals. Although this is a benefit in reducing weed competition, it also reduces the establishment of late germinating prairie species. Established prairie plantings that are burned occasionally show little evidence of weed invasion except for occasional persistent perennial weeds from the initial plantings. Burning, however, was a safety concern of the majority of respondents.

Erosion Control Prairie was considered to be effective for erosion control. However, it was not considered to be superior to brome or bluegrass sods. Concern was expressed that the slowness of germination and seedling growth kept the land open to erosion for the first year or two after a prairie planting was initiated. Temporary companion, or nurse, crops, which establish quickly but offer little permanent competition to the native species, are often recommended where wind and water erosion are problems. Sixty-seven percent of respondents (n = 49) said they used companion crops, particularly oats, ryegrass, sudan grass, and sprangletop.

Costs Respondents earlier in the survey stated that costs were a landscape planning concern. When asked if native plantings such as prairie are cost-effective, 4 respondents said no, 20 said yes, and the remaining 64 said that it was too soon to tell. Those who said yes cited that once the prairie was established, little replacement and maintenance was required. Although long-term costs of prairie plantings have not been documented, 84 percent of those who have planted prairie believe that prairie will be less costly to maintain than traditional or standard grass-dominated mixes of bluegrass, fescues, ryes, and bromes.

Several respondents were skeptical about the cost-effectiveness of prairie because of the "extras of planting and

managing," such as different equipment than that used for seeding turf grasses, the need for a different management schedule, and seed costs. Although survey results show that prairie is typically planted at 10 to 15 lb per acre, compared with 80 lb or more per acre for bluegrass and ryegrass plantings, prairie seed can cost up to 10 times as much as bluegrass seed. In a recent Wisconsin planting where the pure live seed ratio of grasses to wildflowers was 60:40 for 4 grasses and 16 wildflowers, seed and establishment costs were $1,600 to $1,800 per acre. When states add in maintenance costs, however, some respondents stated that prairie plantings become quite competitive with those of bluegrass-dominated mixes. Specific cost comparisons between prairie maintenance and traditional grass mixes have been too infrequent to draw any general conclusions.

Seed Availability In addition to its often high cost, the availability of prairie seed is perceived to be limited. Seeds of prairie plants (except range grasses) have had limited commercial production, and frequently production is inadequate to support the acreages that transportation departments are involved with. Seeds of prairie plants also tend to lack the high germination and vigor of many traditional turf grasses and cool-season weeds.

What Techniques Are Used to Plant Prairie and How Successful Are They?

Applying seed with a drill after plowing and disking the seedbed to eliminate weed growth is a common method of implementing a prairie (*3*). Other methods of establishing prairie include no-till seeding (*10,11*), hydroseeding, and transplanting (*12*). Drilling ensures even seed dispersal at a predetermined depth and establishes a firm seedbed but has limited use on highway slopes of 3:1 or greater. Drilling also requires a relatively long site preparation time and opens slopes to potential erosion.

No-till operations have the advantage of requiring little seedbed preparation, thus reducing soil disturbance. Sites that have minimal competition and sparse groundcover can often be seeded directly with a no-till drill. Hydroseeding has been used on steeper slopes, on which drills and no-till machinery are difficult to operate. Transplants have been used to supplement existing vegetation and to shorten establishment periods (*12*).

Respondents (n = 60) who have planted prairie or have been involved in related department actions were asked to indicate the methods of planting prairie in which they have had experience and the relative success or failure of each. Drilling, no-till seeding, and hydroseeding have been used by the majority of respondents, with drilling having the greatest percent of respondent use (67 percent) and satisfaction (48 percent). Drilling also had the lowest percent of respondents (7.5 percent) that believe it has a high rate of failure.

Both no-till seeding and hydroseeding have been tried by 60 percent of the respondents and appear to be equally successful, with 28 percent rating them as "working well" and 23 percent and 16 percent of the respondents reporting failed attempts, respectively. Hydroseeding received some of the following comments; "wind erosion often blew the seed away," "the seed did not germinate possibly due to a lack of moisture," and "the seedlings of those seeds that did germinate died during the first growing season." Others reported that hydroseeding required three times the amount of seed that drilling does.

Approximately 26 percent of the respondents also found transplants satisfactory; however, fewer of the respondents (35 percent) have actually tried this method. Transplant problems included the need for irrigation, a high rate of failure, and high expense.

How Are Prairie Plantings Managed?

The prairie is a plant community that evolved under both climate and disturbance regimes of fire and grazing (*13*). Fire provides many benefits to the viability and stability of these communities including the ability to reduce invasion from woody plants and cool-season grasses and the ability to stimulate growth in prairie plants (*14–16*). For these reasons, prescribed burns are a recommended management tool for prairie (*14,17*).

Because fire has limitations in modern-day settings, alternative mechanisms have been tried with varying degrees of success to replace the role of fire in the prairie ecosystem. Mowing has generally been considered a possible management tool but has limited effectiveness in eliminating aggressive cool-season grasses (*18*) and requires additional thatch removal equipment. Mowing in areas where prairie or native grasses are planted is best done in early spring or late fall to correspond with the growth of cool-season plants and the dormancy of warm-season grasses; however, these time periods do not fit the maintenance schedules of many departments.

Respondents were asked which of a variety of management methods were used on agronomic grasses (bromes, fescues, ryes, etc.) and which were used on native grasses. Comparisons were done among mowing, plant growth regulators, herbicides, controlled burning, and no treatment (Figure 2).

Although mowing was by far the main tool used to manage agronomic grasses and turf, it was rated as having the shortest length of effectiveness—only 30 to 60 days (Figure 3). Mowing was also the main management tool used on native grasses, although fewer respondents reported it as a normal practice. Respondents also agreed that prairie required less frequent

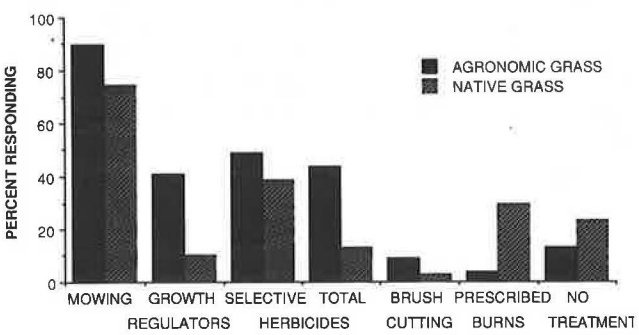

FIGURE 2 Management treatments applied to agronomic and native grasses.

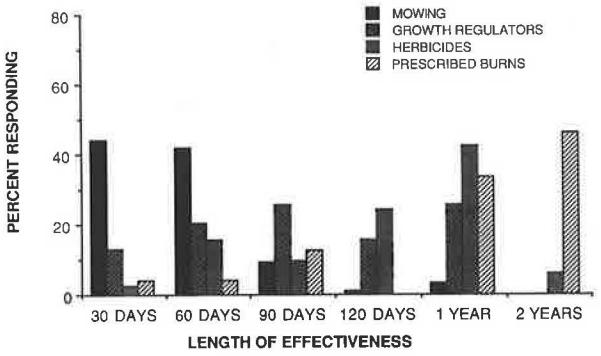

FIGURE 3 Length of effectiveness of management treatments.

mowing than did turf grasses. Herbicides, which were rated as lasting longer than mowing, (generally 120 days to 1 year) were reported as being used on agronomic grasses by approximately 45 percent of the respondents. Thirty-eight percent reported using herbicides in areas with native grasses but with less frequent applications than areas consisting of agronomic grasses. Plant growth regulators were used by 41 percent of the respondents on agronomic grasses and by 10 percent on native grasses. Even though controlled burning was rated as having the longest period of effectiveness (1 or more years), less than 4 percent use burning on agronomic grasses. On the other hand, 29 percent used burning on native grasses. Native grasses were also put on a no-management policy by 23 percent of the respondents. Less than 13 percent provided no treatment to agronomic grasses.

Survey questions were asked to find out which states were using prescribed burns as a management tool. One-fourth of the respondents, from four states located in the northern and eastern portions of the survey area, stated that they have used burning in treatment of prairie on roadsides. Of those states that do burn, 90 percent of the respondents remarked that they do so on fewer than 10 mi per year. Approximately 5 percent of the respondents remarked that their states burn between 10 and 100 mi per year.

The frequency of natural fires for any one area of prairie at the time of European settlement has been estimated at 1 for every 3 to 10 years (*14*). Rhizomes show greater growth and spread where burning is more frequent. Sites of native warm-season grasses that are burned at intervals greater than 5 years begin to show decline as a result of litter buildup (*16,19*). Prairie plantings on roadsides are currently burned on an irregular basis or every third year according to those respondents [32 percent, (n = 25)] who burn. Twenty-eight percent burn such plantings every other year, and 8 percent do so annually.

Burning can be labor intensive. However, most departments do not burn prairie on a yearly schedule. On the other hand, departments tend to mow areas two to three times a year. Respondents were asked to compare the costs of burning with mowing prairies. Of those who have had experience in burning prairies, 17 stated that mowing is more expensive (n = 22). Two believed that mowing was less costly than burning, and three believed that the two treatments were similar in costs. No department supplied actual cost comparisons.

Respondents who do not burn were asked to respond to a series of variables on why they do not. Safety concerns for motorists (78 percent), agency policy (65 percent), and potential threats to adjacent properties (60 percent) were the most frequently cited reasons for not burning. Gaper's block (the slowing or stoppage of vehicles by distracted drivers) and smoke drifting across traffic lanes were also considered by respondents to be major safety problems. Less than 24 percent of the respondents agreed that a lack of trained personnel, a lack of equipment, or an inability to receive permits from local authorities were reasons that they did not burn.

Is Knowledge on Prairie Installation and Management Available and Sufficient?

Perhaps one of the major impediments to the use of prairie is lack of knowledge and information. More than half of all respondents agreed that technical information on managing prairie was not readily available. Those who planted prairie reported information to be more available than those who had not (Table 5). The lack of access to information may contribute to the fact that more than 40 percent find prairie difficult to establish. Information on species selection, seed sources, propagation, and site preparation was accessible for most and was adequate in its coverage of the subject (Table 8).

Who is Conducting Research

Although states permit research on vegetation management within ROW, few individuals appear to be aware of the research results. Research on roadside vegetation is being conducted by departments, according to 77 percent of the respondents; however, only 16 percent of the respondents acknowledged that research results have been published in a form that would be available to other ROW managers, and 44 percent did not know if or when research results were published. The survey responses indicate that not all respondents are familiar with their state's research activities.

Sources of Information for Vegetation Management

The majority of respondents found nearly all sources listed in Table 9—industry, related occupations, agencies, and trade journals—to at least be somewhat helpful in providing information on the management of natural roadside vegetation. The greatest help came from state DOTs, chemical representatives, ROW managers, and landscape architects, with landscape architects and state DOTs having the highest annual frequency of use (Table 10). Plant ecologists, wildlife ecologists, and departments of natural resources were rated as helpful by one-half of the respondents but were never used by approximately 42 percent of the respondents. Other sources of information found to be valuable by several respondents included the Soil Conservation Service, Association for the Use of Native Vegetation in Landscape Through Education, and the National Roadside Vegetation Managers Association.

TABLE 8 ADEQUACY OF INFORMATION ON PRAIRIE ESTABLISHMENT AND MANAGEMENT

INFORMATION CATEGORIES	N=	% OF RESPONDENTS FINDING INFORMATION TO BE: MORE THAN ADEQUATE	ADEQUATE	LESS THAN ADEQUATE	NOT AVAILABLE
SPECIES SELECTION	84	8.3	58.3	28.6	4.8
SEED AND PLANT SOURCES	84	11.9	48.8	36.9	2.4
PROPAGATION METHODS	84	7.1	48.8	35.7	8.3
SITE PREPARATION METHODS	83	8.4	62.7	26.5	2.4
INSTALLATION METHODS	83	10.5	59.3	25.6	4.7
LANDSCAPE PLANNING	84	3.6	54.8	33.3	8.3
INITIAL MANAGEMENT	84	2.4	45.2	46.4	6.0
LONG TERM MANAGEMENT	84	4.8	44.0	42.9	8.3
VALUES OF NATIVES	84	7.1	52.4	36.9	3.6

TABLE 9 HELPFULNESS OF INFORMATION SOURCES ON NATIVE PLANTINGS

SOURCES OF INFORMATION	N=	% OF RESPONDENTS FINDING INFORMATION TO BE: VERY HELPFUL	SOMEWHAT HELPFUL	NOT HELPFUL	NOT USED
ROW MANAGERS	85	49.4	42.4	1.2	7.1
CHEMICAL INDUSTRY	85	36.5	54.1	3.5	5.9
MACHINERY INDUSTRY	84	6.0	50.0	13.1	31.0
LANDSCAPE ARCHITECTS	85	47.1	41.2	3.5	8.2
PLANT ECOLOGISTS	82	26.8	31.7	3.7	37.8
WILDLIFE MANAGERS	81	11.1	38.3	13.6	37.0
UNIVERSITY EXTENSION	85	34.1	41.2	9.4	15.3
DEPT NAT. RESOURCES	81	22.2	27.2	9.9	40.7
FED. TRANSPORTATION DEPT.	82	4.9	18.3	15.8	61.0
STATE TRANSPORTATION DEPT.	75	65.3	28.0	0.0	6.7
CONTRACTORS	84	25.0	47.6	3.6	23.8
TRADE JOURNALS	84	23.8	58.3	2.4	15.5

TABLE 10 INFORMATION SOURCES AND FREQUENCY OF USE

SOURCES OF INFORMATION	N=	% OF RESPONDENTS USING SOURCES: 1 TO 5 TIMES	6 TO 10 TIMES	MORE THAN 10 TIMES	NOT USED
ROW MANAGERS	84	71.4	16.7	4.8	7.1
CHEMICAL INDUSTRY	84	53.6	3.6	1.2	41.7
MACHINERY INDUSTRY	82	46.3	25.6	14.6	13.4
LANDSCAPE ARCHITECTS	80	42.5	7.5	5.0	45.0
PLANT ECOLOGISTS	81	45.7	8.6	2.5	43.2
WILDLIFE MANAGERS	84	51.2	6.0	1.2	41.7
UNIVERSITY EXTENSION	84	59.5	14.3	6.0	20.2
DEPT NAT. RESOURCES	79	44.3	3.8	7.6	44.3
FED. TRANSPORTATION DEPT.	78	24.4	2.6	1.3	71.8
STATE TRANSPORTATION DEPT.	72	40.3	29.2	23.6	6.9
CONTRACTORS	81	49.4	16.0	9.9	24.7
TRADE JOURNALS	82	51.2	19.5	9.8	19.5

CONCLUSIONS

Comments that prairie plantings are being used as a "replacement (for traditional plant materials) in weedy areas, eroded or droughty rocky slopes, and large mowed areas" are indicative of survey responses that prairie is competitive, effective as an erosion control cover, tolerant of droughty conditions, and requires minimal mowing. Respondents also considered prairie to be visually attractive. Prairie plantings were rated superior to bluegrass and brome sods for all the above characteristics except erosion control effectiveness for which they were considered equal.

If prairie is equal to or superior to more traditional planting types in terms of management costs, attractiveness, and environmental tolerances, why is it not planted more? There are several possible explanations based on what roadside planners and managers know and require of roadside plantings, including the following.

1. Previous experience with a particular species. Planners stated that previous experience with plants was important in designating them for use. As prairie plants are fairly recent ROW planting material, a planner's experience and familiarity with them is likely to be limited. In addition, prairie species and other native ground flora are not common in the traditional nursery industry and until recently have not been highly advertised or "visible."

2. Material Availability. Low seed availability and costs may restrict transportation departments from participating in more prairie plantings. Recent government set-aside programs for agricultural lands have made the growing of native grasses a much more profitable enterprise and have reduced already limited stocks in many agricultural areas. Several states in the eastern regions of the study area are currently engaged in developing state-administered seed farms to supplement highway plantings.

3. Establishment ease. Respondents selected establishment ease as the top criteria for selecting plantings to place in ROW, a criteria for which prairie plantings rated poorly. Ironically, the states who reported the greatest amount of prairie plantings also contained the highest number of respondents who believed it was difficult to establish, suggesting that criteria other than establishment ease are important to its use. The slow development of prairie may also concern managers, particularly where immediate erosion control is needed. At least one state is considering conducting research to determine the germination and seedling needs of species that are difficult to grow.

4. Management Techniques. Infrequent mowing appears to be the management tool roadside managers are using on native vegetation. Prescribed burns and a "hands-off" management policy are also used by only a few respondents. Mowing has proven useful in the initial stages of development, but research suggests that without the removal of thatch, native

grasses will decline and allow competitive undesirable plants to invade. The perceived lack and limited dissemination of available knowledge on the management of prairie may also be a factor in the willingness of an agency to participate in such plantings.

If native vegetation is to gain favor as a roadside planting material, then department personnel, particularly policy makers, must recognize and understand its value and purpose and promote its planting to be followed by monitoring and research reports on planting and management methods. Prairie plantings are minor components of the ROW landscape, but with recent trends toward reducing maintenance, increasing environmental awareness, and restoring natural settings, its use, along with that of other native vegetation types, may increase. On the basis of present knowledge, prairie appears to be a viable and well-adapted vegetation type for many roadsides and one that deserves additional study.

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