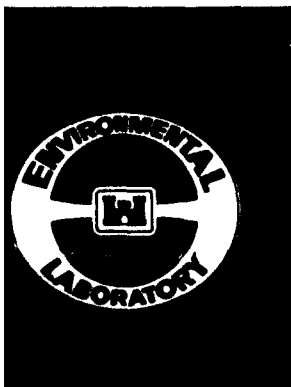


AD-A246 242



US Army Corps
of Engineers



TECHNICAL REPORT EL-91-16

2

GROUND'S MAINTENANCE: STANDARDS, PRACTICES, AND ALTERNATIVES

by

Linda D. Peyman-Dove

Environmental Laboratory

DEPARTMENT OF THE ARMY

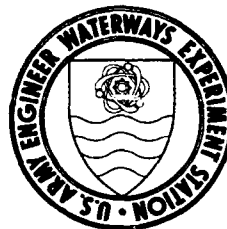
Waterways Experiment Station, Corps of Engineers
3909 Halls Ferry Road, Vicksburg, Mississippi 39180-6199

and

Bonnie S. Martin

Clemson University
Clemson, South Carolina 29631

DTIC
ELECTE
FEB 24 1992
S B D



December 1991

Final Report

Approved For Public Release; Distribution Is Unlimited

92-04490



Prepared for US Army Engineering and Housing Support Center
Fort Belvoir, Virginia 22060-5516

92 2 20 010

Destroy this report when no longer needed. Do not return
it to the originator.

The findings in this report are not to be construed as an official
Department of the Army position unless so designated
by other authorized documents.

The contents of this report are not to be used for
advertising, publication, or promotional purposes.
Citation of trade names does not constitute an
official endorsement or approval of the use of
such commercial products.

REPORT DOCUMENTATION PAGE			Form Approved OMB No. 0704-0188	
Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188), Washington, DC 20503				
1. AGENCY USE ONLY (Leave blank)	2. REPORT DATE December 1991	3. REPORT TYPE AND DATES COVERED Final report		
4. TITLE AND SUBTITLE Grounds Maintenance: Standards, Practices, and Alternatives		5. FUNDING NUMBERS		
6. AUTHOR(S) Linda D. Peyman-Dove, Bonnie S. Martin				
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) USAE Waterways Experiment Station, Environmental Laboratory, 3909 Halls Ferry Road, Vicksburg, MS 39180-6199; Clemson University, Clemson, SC 29631		8. PERFORMING ORGANIZATION REPORT NUMBER Technical Report EL-91-16		
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES) US Army Engineering and Housing Support Center Building 2593, Fort Belvoir, VA 22060-5516		10. SPONSORING/MONITORING AGENCY REPORT NUMBER		
11. SUPPLEMENTARY NOTES Available from National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161				
12a. DISTRIBUTION/AVAILABILITY STATEMENT Approved for public release; distribution is unlimited		12b. DISTRIBUTION CODE		
13. ABSTRACT (Maximum 200 words) This report focuses on practices that offer opportunities to reduce mowing and other grounds maintenance costs. The primary practices that will be discussed include the use of low-maintenance vegetation, such as wildflowers and native grasses, and the use of chemical control, such as plant growth regulators. A questionnaire was developed and distributed to Army installations and other public land use agencies to compare the Army's mowing standards and practices to those of other agencies. Questionnaire results are summarized in this report.				
14. SUBJECT TERMS See reverse		15. NUMBER OF PAGES 62		
		16. PRICE CODE		
17. SECURITY CLASSIFICATION OF REPORT UNCLASSIFIED	18. SECURITY CLASSIFICATION OF THIS PAGE UNCLASSIFIED	19. SECURITY CLASSIFICATION OF ABSTRACT		20. LIMITATION OF ABSTRACT

14. (Concluded).

Chemical mowing	Native grasses	Wildflowers
Grounds maintenance	Native vegetation	
Low-maintenance vegetation	Plant growth regulators	

PREFACE

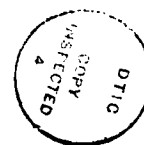
The study reported herein was conducted for the US Army Engineering and Housing Support Center, Fort Belvoir, VA. The report was prepared by Ms. Linda D. Peyman-Dove, Resource Analysis Group (RAG), Environmental Resources Division (ERD), Environmental Laboratory (EL), US Army Engineer Waterways Experiment Station (WES), and Ms. Bonnie S. Martin, Clemson University.

The work was performed under the direct supervision of Mr. H. Roger Hamilton, Chief, RAG, and under the general supervision of Dr. Conrad J. Kirby, Chief, ERD, and Dr. John Harrison, Chief, EL. Technical reviewers were Mr. Larry Lawrence, RAG, and Ms. Linda S. Nelson, Aquatic Processes and Effects Group, EL. Mr. Larry Lawrence also provided technical advice and assistance. Ms. Peyman-Dove was the Principal Investigator.

Commander and Director of WES was COL Larry B. Fulton, EN. Technical Director was Dr. Robert W. Whalin.

This report should be cited as follows:

Peyman-Dove, Linda D., and Martin, Bonnie S. 1991. "Grounds Maintenance: Standards, Practices, and Alternatives," Technical Report EL-91-16, US Army Engineer Waterways Experiment Station, Vicksburg, MS.



Accession For	
NTIS GRA&I	☒
DTIC TAB	☐
Unannounced	☐
Justification	
By	
Distribution	
Availability Codes	
Dist	Special
A-1	

CONTENTS

	<u>Page</u>
PREFACE.....	1
CONVERSION FACTORS, NON-SI TO SI UNITS OF MEASUREMENT.....	3
PART I: INTRODUCTION.....	4
PART II: LITERATURE REVIEW.....	5
Chemical Mowing.....	5
Low-Maintenance Vegetation.....	10
Summary.....	16
PART III: SURVEY METHODS.....	18
PART IV: RESULTS OF SURVEY.....	19
Category 1: Conventional Mowing.....	19
Category 2: Low-Maintenance Vegetation.....	22
Category 3: Chemical Mowing.....	27
Category 4: Overseeding and Fertilization.....	37
PART V: CONCLUSIONS AND RECOMMENDATIONS.....	38
Conclusions.....	38
Recommendations.....	41
REFERENCES.....	43
APPENDIX A: GROUNDS MAINTENANCE QUESTIONNAIRE.....	A1

CONVERSION FACTORS, NON-SI TO SI
UNITS OF MEASUREMENT

Non-SI units of measurement used in this report can be converted to SI
units as follows:

<u>Multiply</u>	<u>By</u>	<u>To Obtain</u>
acres	4,046.873	square meters
feet	0.3048	meters
inches	2.54	centimeters
miles (US statute)	1.609347	kilometers

GROUNDS MAINTENANCE:
STANDARDS, PRACTICES, AND ALTERNATIVES

PART I: INTRODUCTION

1. This report was prepared for the US Army Engineering and Housing Support Center, Natural and Cultural Resources Section. The objective of this study was to compare the grounds maintenance standards and practices at Army installations with other public land-use agencies, in an attempt to identify methods by which grounds maintenance costs at Army installations can be reduced. Particular attention is paid to conventional mowing due to the high cost associated with this activity.

2. This report contains questionnaire results from Army installations and four other public land-use agencies and a literature review of grounds maintenance practices, including low-maintenance vegetation and chemical mowing. Conclusions and recommendations based on the questionnaire and literature review are also provided.

PART II: LITERATURE REVIEW

3. Federal, State, and local governments are finding themselves faced with increasing fiscal restraints, which are forcing them to explore low-cost alternatives to traditional grounds maintenance practices. With the continual rise in the cost of labor, equipment, and fuel, those responsible for grounds maintenance are under pressure to reduce mowing costs, which are usually the highest cost item in the maintenance budget.

4. With mowing costs averaging \$32.55/acre on flat, easy-to-mow areas and \$55.63/acre for difficult-to-mow areas (Hagman 1983), and with millions of acres to be mowed on limited budgets, public agencies are examining a variety of techniques for lowering maintenance expenditures. Some agencies consider contract maintenance to be a cheaper method of maintenance (Buffington 1987, Kerr 1979). However, whether using contract or in-house maintenance personnel, grounds managers must be aware of the latest technology and trends in order to contend with budget limitations.

5. Recent research and product development, combined with a return to natural, environmentally oriented approaches, have given grounds managers a variety of options for implementing cost-saving maintenance. Two of the most important of these are the use of chemical mowing and low-maintenance vegetation.

Chemical Mowing

6. Chemical mowing can be defined as the use of chemicals, such as plant growth regulators (PGRs) and/or herbicides, to prevent or reduce the growth of vegetation so that the need for mechanical mowing is either eliminated or reduced (Morre', undated; Danneberger and Street 1986). One industry expert expects use of PGRs by rights-of-way managers to increase tenfold each year for the next 10 years (Weeds Trees & Turf 1986).

Plant growth regulators

7. A PGR is a synthetic chemical compound that alters the behavior of plants through physiological action. Unlike herbicides, a PGR is not designed to kill a plant. Instead, PGRs change normal physiological and/or morphological plant processes and growth (Hagman 1983).

8. Research on PGRs has accelerated since the 1960's when Purdue University began examining growth regulator compounds. The initial objective of

Purdue's research was to find a growth regulator that would either eliminate or reduce the frequency of required mowing, thus reducing fuel and labor costs and equipment depreciation (Freeborg 1983).

9. While most managers agree that the use of growth regulators and herbicides does not replace mowing, PGRs have been successfully used in a number of ways. Plant growth regulators can delay the onset of spring mowing, reduce mowing frequency, and provide more uniform seasonal mowing schedules (Kaufmann 1985, 1986). Another consequence of suppressing shoot growth by PGRs is the reduction of evapotranspiration, which reduces the amount of required watering (Beard 1985). In areas suffering from drought or near-drought conditions, this can be extremely important to grounds managers.

10. In general, one PGR application is effective for up to 7 weeks, with the average being 6 weeks.* The frequency of PGR application and the subsequent need for mowing are dependent on the grass species and maintenance standards of a particular type of area. For instance, while State Highway Departments may be satisfied with a grass height of up to 12 in.** along roadsides, this would be untenable at rest areas or visitor centers.

11. The characteristics of an ideal PGR for use on turf would be: reasonably long residual activity, inhibition of seedhead and stalk formation, no objectionable discoloration or chemical burning of the turf, control or suppression of broadleaf weeds, no reduction in turfgrass quality with repeated usage, and low toxicity to desirable vegetation. So far, this PGR does not exist. Therefore, when considering the use of PGRs it is important to understand both the problem and the desired outcome of the treatment (Danneberger and Street 1986; Watschke, Lyman, and Prinster 1988).

12. Potential side effects from the use of PGRs include initial, temporary discoloration when applied at rates to suppress growth; greater than normal growth rate after the effects of the PGR dissipate (lasting approximately 10 days); reduced capability of recovering from injury; and in already diseased turf, a more pronounced appearance of disease due to lack of new growth (Beard 1985). Lower turf density is another potential result of PGR application and can result in loss of soil stability, erosion, and excessive water runoff (Danneberger and Street 1986).

* Personal Communication, June 1989, W. G. Menn, Texas A&M, College Station, TX.

** A table of factors for converting non-SI units of measurement to SI units is presented on page 3.

13. The use of PGRs on improved grounds is very limited due to the requirement for a high-quality appearance. Improved grounds include areas with both high- and low-intensity use, such as parade grounds, drill fields, intramural athletic fields, visitor centers, and similar areas in which appearance is important. Plant growth regulators are rarely used on these areas because of the possibility of discoloration (Beard 1985; Watschke, Lyman, Prinster 1988; Kaufmann 1986). However, PGRs have been used quite successfully on semi-improved grounds. Semi-improved grounds include non-high-traffic areas such as roadsides, open areas along roadsides, utility easements, developed picnic and camping areas, and airfields. The greatest potential for cost-effective use of PGRs is on turf and vegetation in semi-improved grounds that "receive frequent mowing but few other management inputs" (Kaufmann 1986).

14. Although early use of PGRs indicated unsatisfactory results, more recent reports have generally been positive. Improved chemical formulations have resulted in more effective results. Unsatisfactory results of PGR use can usually be attributed to one or more of the following: improper application timing, irregular application patterns such as skips and/or spray overlap; improper application rate; subsequent cultural stress (e.g., scalping, overfertilization); or PGR application to the wrong type of turf (Kaufmann 1986). However, even with the potential for problems, many agencies report satisfactory results from the use of PGRs. For instance, the Missouri Highway and Transportation Department started experimentation with PGRs in three districts. Results were so positive that the program was expanded to all 10 districts in 1988. According to the Department, the treatment has resulted in no noticeable turf damage in those areas with 3 consecutive years of PGR use (Jett 1988).

15. Similar results have been reported at Howard County Park, Maryland. This park has hilly and marshland terrain, resulting in many areas that are difficult to mow. While initial use of turf regulators was disappointing, more recent use has been encouraging. Mowing frequency in treated areas has been reduced by 60 percent over a 7-week period. Grass is easier to mow, with fewer clippings. Park managers have been so pleased with the results that plans have been made to increase PGR use in coming years (Park Maintenance and Grounds Management 1985).

16. On the golf courses at Reid Memorial Park in Springfield, OH, PGRs have been used on 90 of the 225 acres of rough areas. The cost for spraying

PGRs and two weed killers is about \$20 an acre, and has resulted in a reduction of mowing by 50 percent. According to the Park Supervisor, PGR use has been a definite budget saver, while the quality of the courses has been maintained (Park Maintenance and Grounds Management 1982).

17. At Loudon Park and Druid Ridge, two historic cemeteries in Baltimore, the first PGRs were used with disappointing results. More recent use has impressed those responsible for grounds maintenance. PGRs have cut mowing in an experimental area by 50 percent over a period of 6 weeks, with almost no visible turf discoloration and with fewer clippings. The use of PGRs has been so successful that they are now being used on 17 acres in both cemeteries (Carr 1985).

18. It is interesting to note that reported success with the use of PGRs comes mainly from northern, cool-season grass areas. In general, the use of PGRs has been less successful on warm-season grass species.* Growth suppression of warm-season grasses through the use of PGRs is more difficult due to their tough, persistent growth habit, and the length of the growing season. Herbicides provide one solution to this problem. Herbicides can be used as growth regulators. When certain herbicides are applied at a low rate to warm-season grasses, both grass and broadleaf weed control is possible. While it is also possible to use low-rate applications of herbicides as a growth regulator on cool-season grass species, there is a very narrow margin of safety and accidental overdoses can kill turf easily and quickly (Kaufmann 1986).

Herbicides

19. Chemical mowing also includes the use of herbicides. Herbicides are frequently used in combination with plant growth regulators although, as previously mentioned, they sometimes actually function as a PGR. However, in general, herbicides are used to kill or eradicate weeds, rather than regulate their growth. Weeds are the most common problem in turf management, detracting from the uniformity of the turf and competing with desirable turfgrass species for light, carbon dioxide, soil moisture, and soil nutrients. Weeds are usually the result of poor turf maintenance.

20. Herbicides are potentially a cost-effective means of reducing equipment and manpower costs associated with mechanical mowing. They are

* Personal Communication, June 1989, W. G. Menn, Texas A&M, College Station, TX.

ideal for weed and brush control in inaccessible areas or for reducing mowing by selectively controlling tall, undesirable species, thus allowing low-growing desirable grasses to grow (Kuennen 1986b). Mowing in conjunction with a herbicide treatment is frequently more effective than a herbicide treatment alone, depending on the species of weed and the maintenance standards for that area.

21. A roadside development specialist for the Pennsylvania Department of Transportation has found herbicide use to have several advantages. He gives the following reasons for his plans to continue herbicide use for maintaining shoulder areas in the coming years: ease of application of herbicides, fewer employees required for herbicide application, a decrease in mowing operations, and perhaps most importantly, a cost of \$72/mile for herbicide treatment versus \$500/mile for mechanical vegetation removal. Among the disadvantages of herbicide use are: the possibility of runoff, the brown look of vegetation following the application, and negative public reactions over environmental issues (Kuennen 1986b).

22. It is not unusual for herbicide use by public agencies to result in complaints by the public. People who live adjacent to public land are understandably concerned about the effect of vegetation management programs on their own land, although when applied in the proper manner, herbicides have little direct effect on surrounding land. Conversely, herbicide use sometimes finds favor with the public. Most farmers appreciate the use of herbicides because it prevents weeds from encroaching onto their land and competing with crops (Roads & Bridges 1986).

23. Herbicide treatment that takes into consideration such factors as soil texture, organic matter content, slope of the site, and solubility and persistence of the product will determine the risk of lateral and vertical movement of the herbicide from the treated area (Doll 1988). It is important for all grounds maintenance departments that are using herbicides to have employees who have been trained in herbicide application (Bolt 1988, editors Roads & Bridges 1986). Employees properly trained in herbicide application accomplish three things: they actually do a better, safer job of herbicide application; they feel more confident and comfortable with herbicide use; and public perception toward herbicide use is more positive due to confidence in the expertise of the applicator (Jett 1988).

24. The bottom line for use of chemical mowing is the cost-effectiveness of the program. It is important that the treatment not exceed

the cost of mechanical mowing, and, ideally, it should provide substantial cost savings. Chemical treatments are not cheap. One method of lowering their cost is to combine an additive with the PGR or herbicide treatment. Additives or adjuvants are usually inert materials that, when combined with a PGR or herbicide, increase the effectiveness of the active ingredient (in the herbicide), thereby reducing the application rate of the PGR or herbicide (Morre', undated). For instance, the Maine Department of Transportation adds an orange peel solution to its herbicide water mixes to help the herbicide penetrate the tough, protective layer that leaves develop during seasonal drought conditions. This lowers the amount of herbicide that must be used (Roads & Bridges 1986).

25. Use of both herbicides and PGRs is increasing. A study by the American Association of State Highway and Transportation Officials, conducted in 1980, indicated that mechanical mowing decreased for the years 1970 to 1980 in 38 of the 45 responding states. During that time, nine agencies increased their use of PGRs and 28 increased their use of herbicides (Kuennen 1986b). Another survey shows that 88 percent of rights-of-way managers practice weed control, with nonselective herbicides as their favorite choice of control (Weeds Trees & Turf 1986).

26. Generally, the consensus of those who are presently using chemical mowing as part of their grounds maintenance program is that it is an effective means of reducing mechanical mowing and its related costs.

Low-Maintenance Vegetation

27. Another method for lowering mowing costs is through the use of low-maintenance landscaping. Low-maintenance vegetation can be characterized by the following: reduced irrigation, reduced fertilization, reduced pesticide usage, and reduced mowing frequency (Meyer 1989). The goal of low-maintenance landscaping is to lower maintenance costs of a new or existing landscape without sacrificing quality (Wade 1986). This can be accomplished through the use of native vegetation such as wildflowers and native grasses, or by using ornamental ground cover (Colbert 1983). Native vegetation is, frequently, the mainstay of low-maintenance landscaping programs. Native vegetation

refers to the grasses and plants that are indigenous to an area. Natives are capable of surviving extreme temperature and climatic changes.*

28. Approximately 80 percent of all landscaping involves the use of exotics, plants which have been brought in from other countries or from different areas within this country. Generally, these plants are more difficult to maintain than native plants. Besides a requirement for special fertilizers, exotics usually require more water and have less tolerance of extreme temperature changes than native plants (Leslie 1986).

29. With the differences between native vegetation and exotics in mind, grounds managers who are searching for methods of lowering maintenance costs should certainly be interested in the benefits and costs associated with native vegetation establishment.

Wildflowers

30. One of the most popular methods for establishing low-maintenance vegetation is through the use of wildflowers. Wildflowers are flowers that thrive with little or no care. They are species of flowers that have proven to be hardy and self-reproducing over thousands of years. Wildflowers may require as much time and labor to maintain during the first 3 to 5 years as a mowed area. However, once they are established, almost no further maintenance is required. They thrive on poor soil and need no annual fertilization. An annual mowing to remove stalks and help spread seedheads is all the care they need (Park Maintenance and Grounds Management 1986). This can also be accomplished through controlled burning, which is usually less expensive.**

31. Wildflowers have proven to be popular with both grounds managers and the public. Wildflowers are not only a low-cost, low-maintenance alternative to mowing but also serve as a beautification technique. Benefits other than seasonal color to be derived from wildflowers include: restoration of the environment, erosion control, and habitat enhancement for nongame wildlife (Kuennen 1986a). Wildflowers also are an excellent method of returning natural fertilizers to the soil (State of Texas 1988).

32. Wildflowers are particularly suited for use on semi-improved grounds. Areas in which a manicured look is not necessary or where mowing is difficult are ideally suited to the use of wildflowers. More than half of the

* National Wildflower Research Center (Clearinghouse), Austin, TX.

** Personal Communication, December 1989, Corliss J. Ingels, Lafayette Home Nursery, Lafayette, IL.

States in America have experimented with wildflower plantings along public highways (Leslie 1986). Most notable of these is Texas.

33. Texas has encouraged the planting of wildflowers along their highways for more than 50 years. However, in the last decade wildflowers have become even more important as the state looked for ways to reduce mowing costs. In 1982 the Texas Highways Department instituted a new vegetative management program that has resulted in a mowing cost reduction of 23.1 percent. Increased wildflower use is an important part of this program (Newman, undated). An interesting side effect of this increased wildflower use has been the public reaction. People are throwing less trash from their cars, perhaps because of a reluctance to mar the scenic beauty (Constructor 1988, Leslie 1986). Not only can this result in a more pleasant roadside environment, but maintenance costs are reduced as a result of the reduction in clean-up responsibilities.

34. The State of Vermont attempted wildflower establishment along its interstate highways in 1974. Results were disappointing due to a lack of ground preparation. Vermont, like many states, failed to realize that simply throwing out seed will not result in a beautiful field of wildflowers. In 1986 the State decided to make a second attempt at wildflower establishment. The results this time were much better. All of the annuals bloomed, providing not only beauty for a season, but essential cover and growing space for developing biennials and perennials (Dusablon 1988).

35. Like Vermont, the Virginia Department of Transportation instituted a wildflower planting project several years ago, but with limited success. Some seed failed to germinate, and weeds invaded other flower beds. However, because of strong public support and plans for improvement, the program is being continued (Bolt 1988).

36. The experience of these two states makes an important point. Wildflowers are not necessarily easier to establish than exotics. During establishment, wildflowers require proper ground preparation, watering, and attention. It takes time for the flowers to propagate. They must be planted in the fall and allowed to establish a root system over the winter (Tiller, Newman, and Dennis 1984). The first year after planting can be disappointing if a field of spectacular color is expected. One way to ameliorate this is by following the example of the State of Vermont in planting annuals that can provide color until the perennials are established (Stroud 1989). With a little effort and a lot of patience the rewards can be very worthwhile.

Wildflowers provide a beautiful, back-to-nature method of easier, cost-saving maintenance, when used in appropriate areas.

Native grasses

37. Native grasses are similar to wildflowers in that they are grasses that have a hardiness that has withstood the tests of time and nature. They are an excellent example of "survival of the fittest." They survive because they have the ability to "exploit certain resources better than their competitors" (Diekelmann and Schuster 1982). A beautiful example of native grass is prairie grass. The tall grasslands of the prairie have special features that make them especially good for use in certain areas as a means of lowering mowing costs. Prairie grasses can survive in soil so sandy it literally blows away without protective cover. Native grasses conserve moisture, prevent erosion, and serve as a soil builder. These grasses are especially beautiful when used as "vista-makers." In areas such as industrial parks where several acres of land serve as a background for buildings, prairie grass affords a beautiful, easily maintained vista that replaces turf quite naturally. Areas in which excavation has left no rich soil are perfect for prairie grass, which will take root and thrive where other plants cannot (Webster 1975).

38. Prairie grass is similar to wildflowers in that it takes about 3 years to establish. Most growth is underground in the roots the first year, with some growth showing by the second. By the third year, the grasses show their full beauty (Webster 1975).

39. It is possible to establish both native grasses and wildflowers in a much shorter period of time. This can be done by using seedlings rather than seed or a combination of both (Creekmur 1987). Fortunately, procedures for producing, processing, and planting seed have been refined since the early 1970's when the concept of restoring native plants to the landscape was relatively new. Only a few years ago the only way to hasten establishment of native vegetation was to transplant sod from small tracts of prairie land that were being condemned for building or construction (Webster 1975). Now, nurseries can provide seedlings, but prices can be prohibitive.

40. Wildflower and native grass seed is also expensive, depending in part on whether the weather conditions are favorable for seed production. For instance, a 1989 price list estimating cost for establishment of wildflower and native grasses gives a range from \$1,500 an acre for a single grass species to \$7,800 for a mix of four to six grasses and eight to fifteen wildflowers using both seedlings and seed. This price includes the cost for

complete site preparation, which can vary according to current site condition (Prairie Restorations, Inc. 1989).

41. Since use of native vegetation has only recently become popular, information as to its cost-effectiveness is fairly sparse. Saylorville Lake, located in central Iowa, provides an excellent example of the cost-effectiveness of prairie grass use. Saylorville Lake is a flood-control and recreation facility operated by the Corps of Engineers. Located in an area that was originally a tall grass prairie zone, less than 1 percent of the original 30 million acres of this region is still prairie. In 1988 a newly constructed campground at the Corps project implemented a plan to restore prairie on the 28-acre site. The campground was designed to be "an aesthetically pleasing, minimum-maintenance facility providing long-term substantial cost savings" (Rolfes et al. 1989). The campground consists of 12 acres of turf and 14 acres of tall grass prairie, with a 30-ft perimeter of midlength grasses to soften the dramatic height difference between the other two areas. Buffalo grass was chosen for the turf area because of its low-growing, sod-forming capabilities. Buffalo grass is a prairie species that requires a minimal, once-a-year mowing after establishment. A comparison of the maintenance requirements of the buffalo grass to those of a cool-season turf used in an adjacent campground shows significant savings with buffalo grass use. Based on a \$24/acre mowing cost for the 12 acres of campground, the annual savings in mowing costs is \$3,182. It was also found that the original cost for seeding the buffalo grass was offset in a single growing season by lowered maintenance costs (Rolfes et al. 1989).

42. Another success story comes from the Illinois Department of Transportation. In 1980 the Department planted 30 acres of prairie and salt grass along Chicago's Eaton Expressway. These grasses are both native to the area and have cut mowing from six times a year to twice annually (Aungst 1986).

43. The two most important factors to consider in the use of wildflowers and native grasses to lower maintenance costs are the cost of establishment and the time required for full development. While the original cost of establishment may seem high, within a fairly short time this cost can be recovered by the lowered maintenance expense. The time factor becomes especially important when the area in question is public land. The public may be skeptical of the necessarily unkempt look of an area for the first couple of years and, thus, must be made aware of the desired end result. Or as Wilcox (1983) states, "Whenever design concepts or maintenance procedures are

altered, it is a good idea to explain the change, instruct people on how to use the new concept, and invite public response." He reports that when the Ohio State Park System made changes in their mowing policy that no longer reflected a "clean cut" image, they anticipated some negative feedback from users. A handout was prepared for distribution to visitors that stressed the benefit of campsites bordered by natural vegetation. A survey of users on the three busiest holidays of the year found few negative comments. As a follow-up measure, the agency's annual newsletter reminds visitors of the new policy and design concept (Wilcox 1983). Another example of positive results from attempts to influence public opinion was reported by Becker, Dottavio, and McDonald (1988). Visitors to the Blue Ridge Parkway were shown photographs depicting mowed and unmowed scenes along the Parkway. A message that included a quotation by Aldo Leopold promoting a more natural environment and a statement about potential cost savings was attached to the photographs. The intention of this message was to influence visitors' preference for mowed or unmowed areas. It was found that the message was indeed successful in creating a positive visitor perception of unmowed areas.

44. Another important factor to be taken into consideration with native vegetation establishment is the availability of seed. It is important to obtain seed from local producers in order to ensure survivability (Rolfes et al. 1989). Not only will seed obtained locally perform better, but local producers are more qualified to give planting advice.

45. Regardless of the amount of time needed for establishing these wildflowers and grasses, the result is worth the wait. The peaceful effect created by the gently waving grasses and the beauty of the wildflowers is a pleasant by-product of an effective substitute for turfgrass in difficult-to-maintain areas. An additional benefit comes from public acceptance of a chemical-free, natural method of maintaining the landscape (Aungst 1986).

Groundcover

46. Groundcover is defined as "any plant lower than three feet in height which, when established, will cover the ground to the extent that underplanting is not required and weeds are excluded" (Steinegger and Todd 1979). Another definition of groundcover is "a large group of plants that in most cases will grow under a wide range of conditions and are generally low growing" (Pointer 1986). Groundcovers are excellent for solving several landscaping and mowing problems. For instance, they can provide cover under trees, shrubs, or in difficult-to-mow spaces where grass would be difficult to

establish or maintain (Orndorff 1986). Properly established and maintained, groundcover can provide lower maintenance than turfgrass. However, some maintenance is required for groundcover plantings. They must be occasionally trimmed, weeded, and fertilized (Stroud 1986).

47. To produce attractive and functional cover in a short period of time, and to do it economically, the plants need the following characteristics: availability at reasonable prices, rapid establishment and growth (regardless of soil quality), low maintenance requirements and long life once established, tolerance of drought and waterlogging, and the ability to withstand worse than average weather (Percy 1985).

48. Groundcover usually takes 2 to 4 years for establishment. Even with the need for more intensive care than native vegetation, ornamental groundcover can solve mowing problems that wildflowers or native grasses cannot. Because of the more manicured look of groundcover, it is especially appropriate for low-intensity use areas of improved grounds where an attractive, manicured appearance is important. Unfortunately, little information is available on the cost-effectiveness of using groundcover as a substitute for turfgrass.

Summary

49. In general, there are many ways of controlling the cost of grounds maintenance, particularly mowing. Chemical mowing is perhaps the most common method. Both herbicides and plant growth regulators are finding increasing favor with grounds managers. Herbicides have been used successfully for many years. When used appropriately, herbicides can reduce mowing frequency, control weeds and brush in inaccessible areas, and control undesirable species that choke out desirable grasses. Negative effects of herbicide use include the possibility of "brownout" of treated plants, movement of the chemical from the treated area, and public displeasure with the use of chemicals. Properly trained employees can reduce the risk of improper application, while educating the public can prevent misunderstanding about the environmental effects of herbicide use. The cost of herbicide treatment is usually much lower than mechanical mowing and is therefore a cost-effective means of lowering mowing costs.

50. Plant growth regulators have become more popular for use in grounds maintenance as new products and formulations are being developed. The PGRs

can be used to regulate mowing and/or reduce mowing frequency. However, PGRs do have some undesirable side effects, including some discoloration, uneven growth if the PGR is applied unevenly, a greater than normal growth rate after the effects of the PGR dissipates, reduced capability of the plant to recover from injury, and lower turf density. Plant growth regulators are also fairly expensive. However, the general consensus of the grounds managers who are using them is that they are an effective means of reducing mowing costs on low-quality areas.

51. Native vegetation such as wildflowers and native grasses can be an effective means of lowering mowing costs when used in appropriate areas. These are excellent for low-quality areas in which a manicured look is unnecessary. These plants are hardy and require very little maintenance once they are established. Seed cost is fairly high, and the time required for establishment is 3 to 5 years. While there may be initial public displeasure at the unkempt look of the area, once establishment is complete there is generally a positive public reaction to this method of landscaping. Native vegetation is becoming an increasingly popular means of lowering maintenance costs.

52. While cost-effectiveness of ground cover is harder to document, it is an acceptable means of eliminating mowing in difficult-to-maintain areas. It is particularly appropriate for use in high-quality areas where other methods of lowering maintenance costs are unacceptable. It would seem reasonable to assume that, at some point in time, the cost of establishment would be offset by the savings realized through the elimination of mowing.

53. With these alternatives to mowing available to grounds managers, perhaps increasing maintenance costs will be less of a problem in the future. Most of these methods have only recently been developed or become popular, presenting many possibilities for future managerial changes in the area of grounds maintenance.

PART III: SURVEY METHODS

54. An understanding of the grounds maintenance standards and practices at Army installations and other public land-use agencies provides an avenue by which we can compare and learn from others. To obtain this understanding, a questionnaire was developed to request information on what the Army and other agencies are doing to curtail conventional mowing costs. A copy of the questionnaire is presented in Appendix A.

55. The questionnaire is divided into four categories:

- a. Category 1: Conventional Mowing
- b. Category 2: Low-Maintenance Vegetation
- c. Category 3: Chemical Mowing
- d. Category 4: Overseeding and Fertilization

56. The questionnaire was sent to 81 Army installations, 27 National Parks, 51 land grant universities, 51 State highway departments, and 21 Corps of Engineers projects. The questionnaire was mailed out in July 1989. For the questionnaires that were distributed, the following response rate was obtained:

Army installations	51 percent
National Park Service	67 percent
Land grant universities	61 percent
State Highway Departments	75 percent
Corps of Engineers projects	95 percent

No follow-up mailings were conducted.

57. Throughout the report, percentages will be given by agency, and are based on the number of responses to each question within that agency (i.e., n = number of responses within that agency).

PART IV: RESULTS OF SURVEY

58. Survey results are organized according to the four questionnaire categories:

- a. Category 1: Conventional Mowing
- b. Category 2: Low-Maintenance Vegetation
- c. Category 3: Chemical Mowing
- d. Category 4: Overseeding and Fertilization

Research questions are used to group the questionnaire results under each category. This facilitates a quick reference to those questions of interest to a particular audience. Some questions are taken directly from the questionnaire, while others represent a combination of questions taken from the questionnaire. Based on the usefulness or validity of the findings, not all questions from the questionnaire are addressed in this report.

Category 1: Conventional Mowing

59. What percentage of the acres for which you are responsible are presently mowed? As illustrated by Figure 1, the percentage of acres mowed by the Army is higher in both improved and semi-improved areas, the only exception being the higher percentage of mowing in semi-improved areas reported by the National Park Service. However, as Figure 2 shows, the National Park Service mows a narrower strip along the roadside than any other agency. The Army and State Highway Departments mow about an 18-ft strip along the roadside, which is about 2 ft more than the Corps and the universities and 6 ft more than the National Park Service.

60. What height vegetation do you maintain? Figure 3 shows that there is little variance in turf height between agencies. The average for improved grounds was between 2 and 4 in. and for semi-improved grounds was 4 to 6 in.

61. The results of the question related to mowing frequency were considered unusable. However, the comments of several respondents show that mowing frequency is generally determined by geographic location and climate.

62. What is the approximate cost to mow per acre? Figure 4 shows that the Army and universities spend substantially less per acre than the other agencies. However, this may be misleading since various managers pointed out exactly what was included in the cost, while others did not. It is possible that all costs (labor, machinery, machinery maintenance, etc.) were not

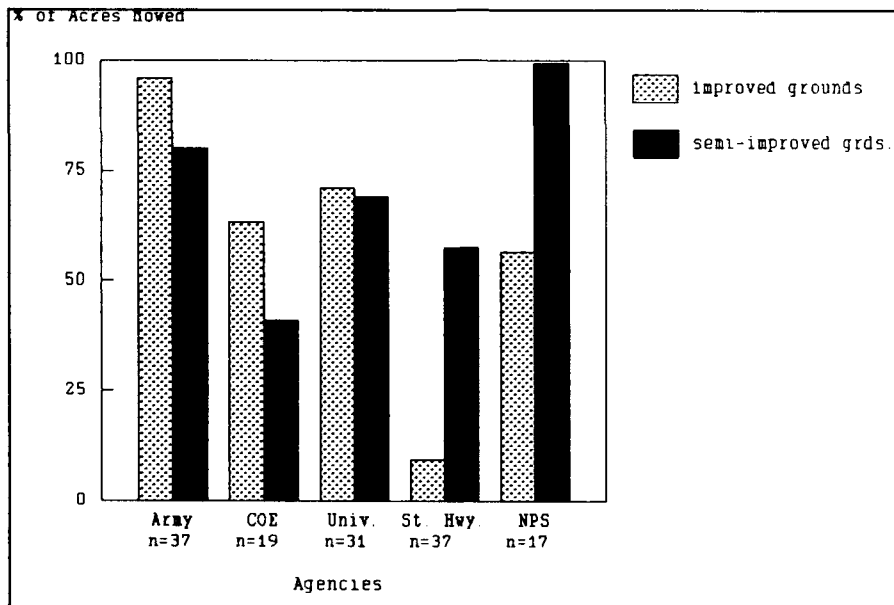


Figure 1. Percentage of total acres responsible for that are mowed

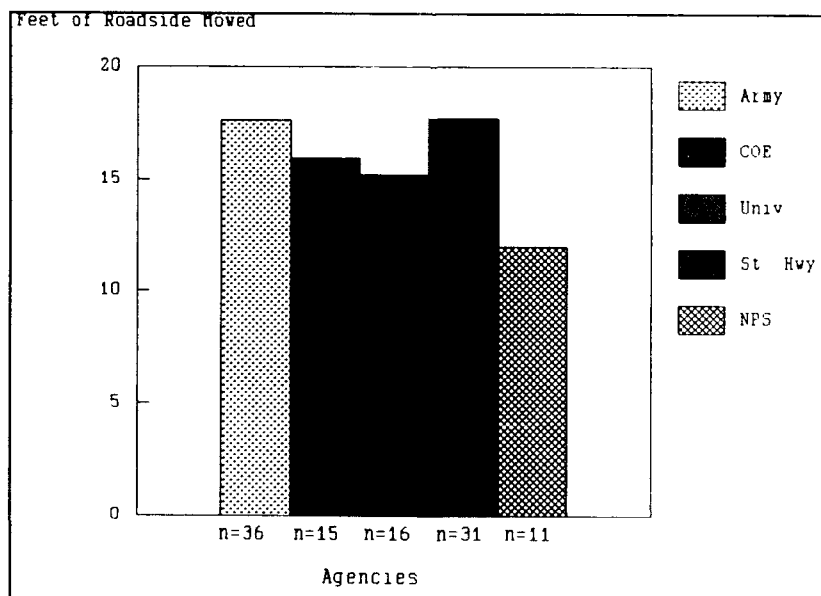


Figure 2. Width of mowed strip along roadside

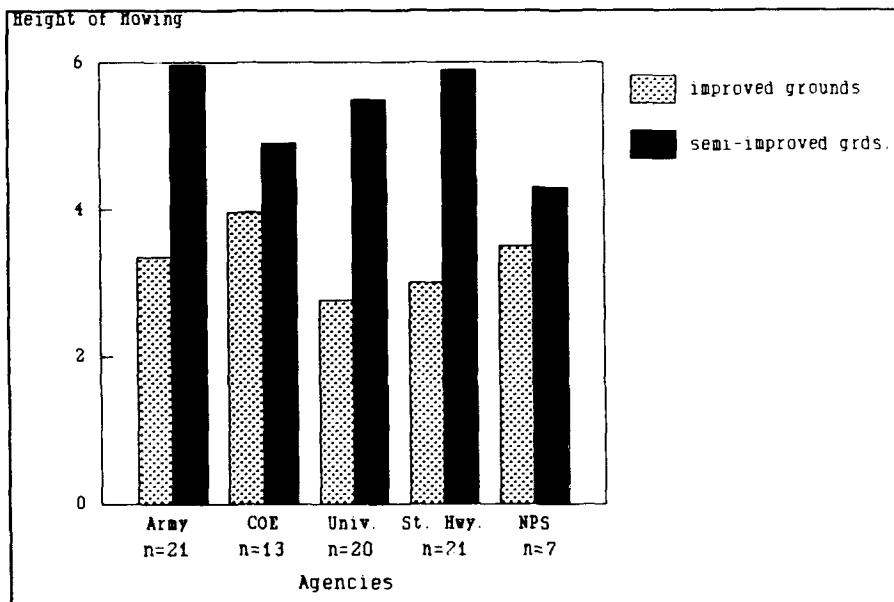


Figure 3. Height of turf mowing

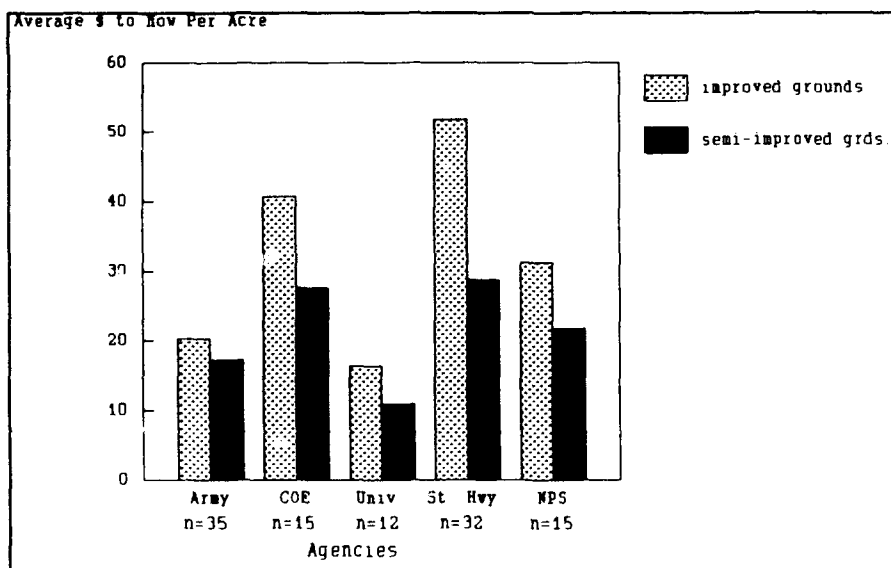


Figure 4. Average cost to mow, per acre

included by all agencies. Comments by various respondents lead to this conclusion.

63. Has the amount of area mowed changed in the past 5 years? As Figure 5 shows, both universities and State Highways report a slight average increase in the number of both improved and semi-improved areas mowed. The Corps of Engineers and the National Park Service show slight decreases for both. However, the Army shows mixed results with an increase in improved grounds and a slight decrease in semi-improved grounds. The Army results reflect an increase in new areas needing maintenance. An increase in budget cuts and natural areas may have resulted in less maintenance of semi-improved grounds. The increase in mowed areas reported by the universities is due to the expansion and additions occurring as a result of growth of the schools. The majority of State Highway Departments report an increase in area mowed because of public demand for mowed right-of-ways and the addition of new areas. There were several reports of decreased mowed area due to budget cuts, the increased use of herbicides, and the return to native vegetation. Budget cuts explain the decrease in mowed area by the National Park Service. Likewise, the majority of the Corps of Engineers projects reported decreased funding as the reason for less mowing.

64. Are you using any other treatment in place of, or in conjunction with, mowing? All agencies report the use of chemical control and low-maintenance vegetation in conjunction with mowing. All agencies except the universities also report the use of controlled burning. Outleashing programs for agricultural hay harvesting are being used by all agencies except the National Park Service and the universities.

Category 2: Low-Maintenance Vegetation

65. Do you use low-maintenance vegetation? All agencies report some use of low-maintenance vegetation. However, as shown in Figure 6, more respondents within the Corps of Engineers, universities, and State Highway Departments are using low-maintenance vegetation than are the respondents from the Army and National Park Service. Also, as shown in Figure 7, the percentage of total acres in which low-maintenance vegetation is used is much greater for the Corps of Engineers than any other agency.

66. For specific respondents not using low-maintenance vegetation, the reasons vary. For instance, the National Park Service respondents frequently

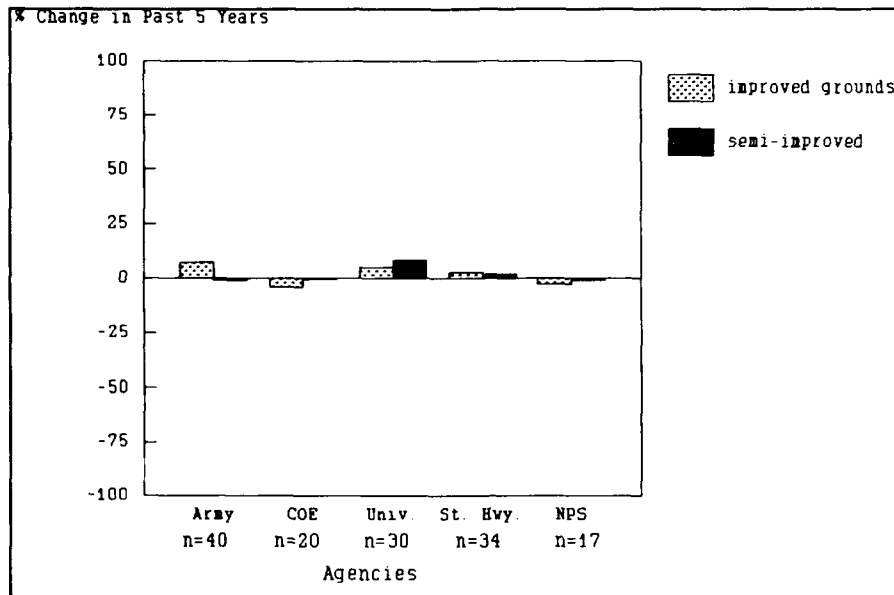


Figure 5. Percentage increase in area mowed over the past 5 years

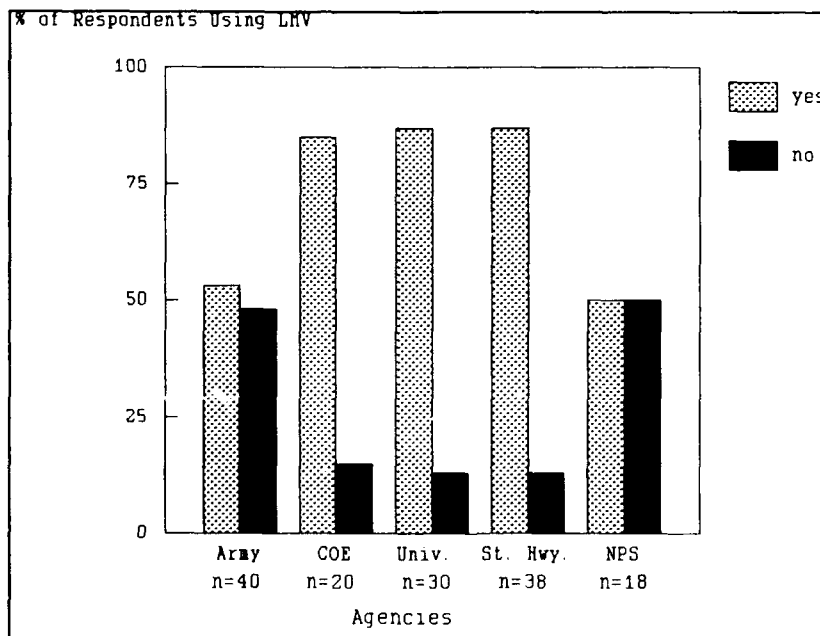


Figure 6. Percentage of respondents using low-maintenance vegetation

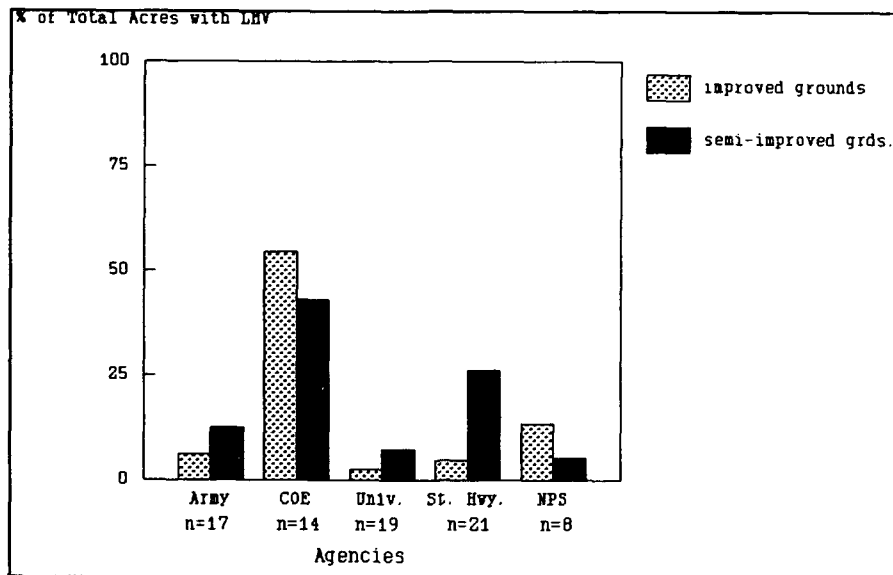


Figure 7. Percentage of total acres with low-maintenance vegetation

gave as their reason the need to preserve the historical landscape and budget constraints. Various Army respondents consider the initial cost of establishment to be prohibitive. Another comment received by an Army respondent was that "traditional command philosophy has called for intense grooming of grounds. The use of low maintenance vegetation has been proposed however."

67. What are your primary purposes for using low-maintenance vegetation? Figure 8 points out that there are many reasons why the various agencies are using low-maintenance vegetation. Reduction of mowing and mowing costs does not seem to be more important than factors such as improving aesthetics, erosion control, and wildlife habitat. While respondents rated the categories provided in the questionnaire, several reasons appeared in the "other" category. These include: irrigation reduction, fertilization reduction, pesticide/herbicide reduction, increased safety, and preservation of natives. Overall, when all categories are considered, no reason seems to outweigh the others in importance.

68. Over the past 5 years, has the amount of acres in low-maintenance vegetation changed? As shown in Figure 9, little increase in the amount of acreage in low-maintenance vegetation has occurred for any agency in the past 5 years. The only exception was a slight increase reported by the National

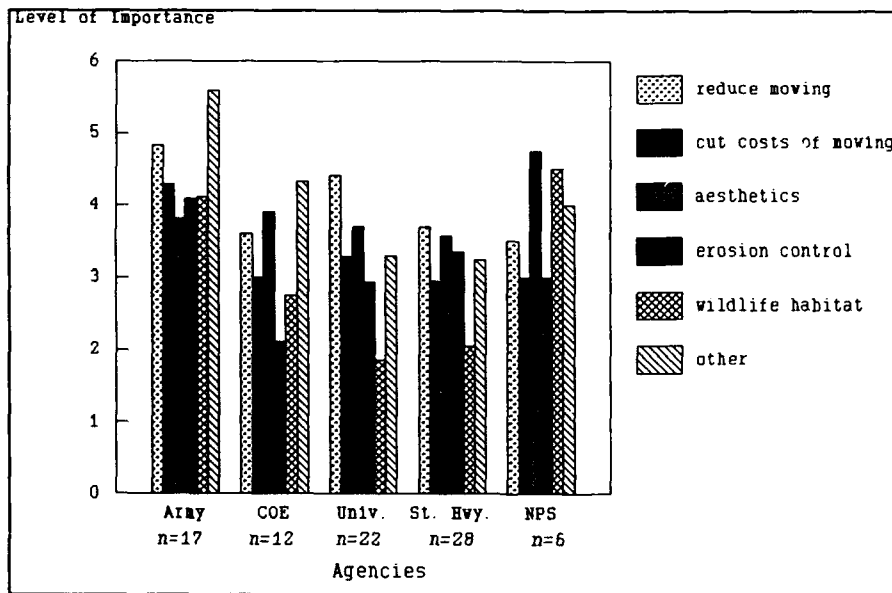


Figure 8. Reasons for using low-maintenance vegetation

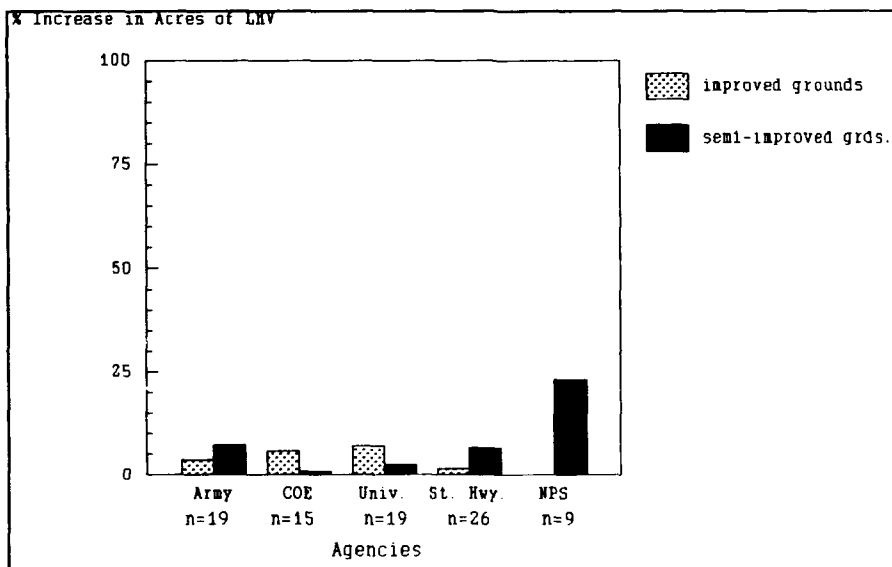


Figure 9. Percentage increase in the amount of acres with low-maintenance vegetation

Park Service on semi-improved grounds. The major reasons for this increase were increased land acquisition, need for reducing water usage and costs, and improved aesthetics.

69. The universities reporting increased usage attribute this to similar reasons. However, they also include reduction of mowing in hard-to-mow areas. Of the State Highway Departments reporting an increase, the primary reasons include experimentation with native grass and wildflower planting, an interest in providing wildlife habitat, and additional acreage created by highway construction. Corps of Engineers and Army respondents report increases in usage to reduce mowing.

70. Was there any public reaction to these changes? Figure 10 shows that overall there was more of a positive reaction on the part of the public than negative. However, many respondents report no reaction on the part of the public. Positive public perceptions come mainly from the aesthetic benefits derived from low-maintenance vegetation. According to the statements of many respondents, this reflects an appreciation for the beauty of wildflowers. However, it must be noted that there is sometimes a negative public reaction when the wildflowers are not in bloom at the end of the season.

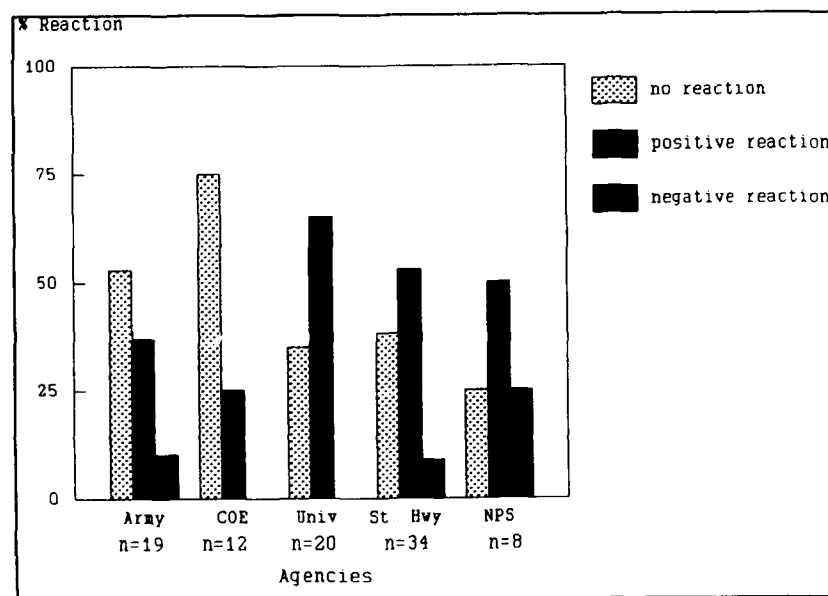


Figure 10. Public reaction to the use of low-maintenance vegetation

71. Was there any administrative reaction to these changes? As shown in Figure 11, there was also more positive than negative reaction on the part of the administration. This was generally attributable to aesthetic improvement and the cost savings realized from less mowing and erosion control. According to one respondent from the Army, "command/administration seem to be coming around to positive reaction as long as they can have intense maintenance in specific areas."

72. In your opinion has the use of low-maintenance vegetation been successful in reducing your grounds maintenance costs? The overall response to this question was strongly positive. Responses were also fairly consistent as to the ways in which costs were reduced. These generally included such factors as reduced mowing, water, and fertilizer costs, and improved safety and erosion control on slopes. Of those using low-maintenance vegetation, the overwhelming majority report that it decreased grounds maintenance costs. While some respondents who are using low-maintenance vegetation report that it has not decreased grounds maintenance costs, these were frequently the ones who reported only short-term use. Many respondents commented on the initial cost associated with plant establishment. Although this cost may be high during the first 3 years, nearly all respondents felt that these costs would eventually be recovered and that overall maintenance costs would be reduced. As stated by one respondent, "After an initial 3-year period of increased maintenance, the use of native plant materials and more drought-tolerant species has helped decrease costs."

Category 3: Chemical Mowing

73. Do you use PGRs in your improved or semi-improved grounds? As shown in Figure 12, a greater percentage of respondents from the State Highway Departments use PGRs than respondents from the other agencies. National Park Service (NPS) policy makes the use of PGRs virtually impossible without special administrative permission. Therefore, all respondents from the NPS report no use of PGRs. Only a small percentage of Corps of Engineers and Army respondents report use of PGRs. Figure 13 illustrates the total acreage and type of areas on which PGRs are being used. It should be noted that more than half the respondents who are using PGRs stated that their use is experimental.

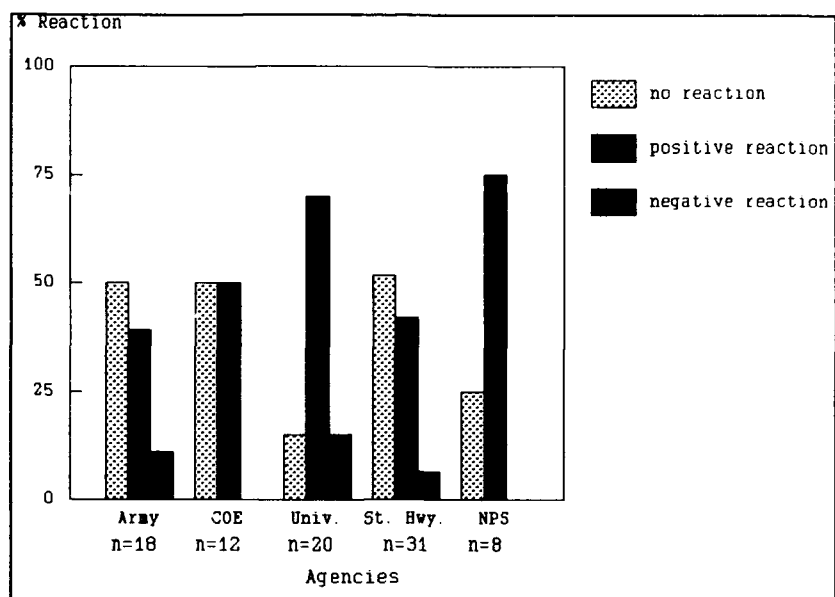


Figure 11. Administrative reaction to the use of low-maintenance vegetation

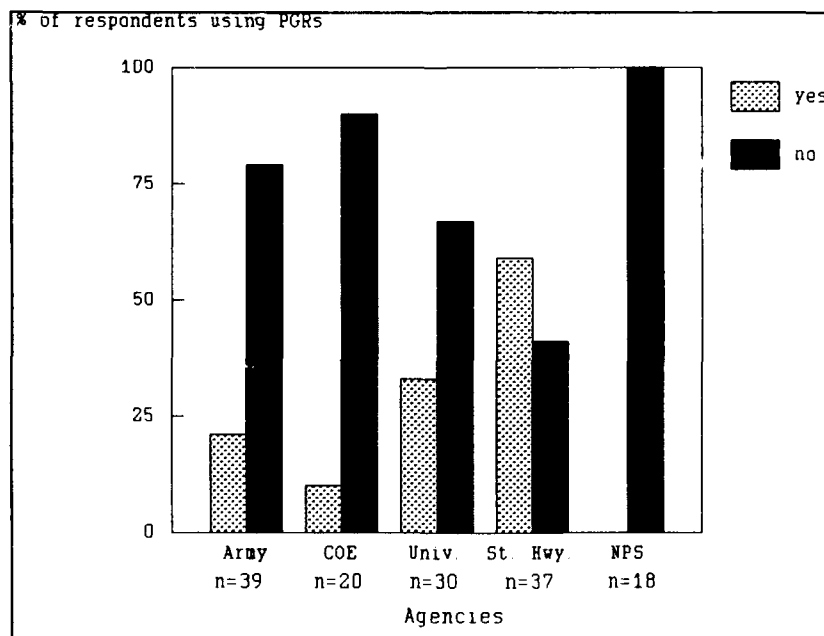


Figure 12. Percentage of respondents using plant growth regulators

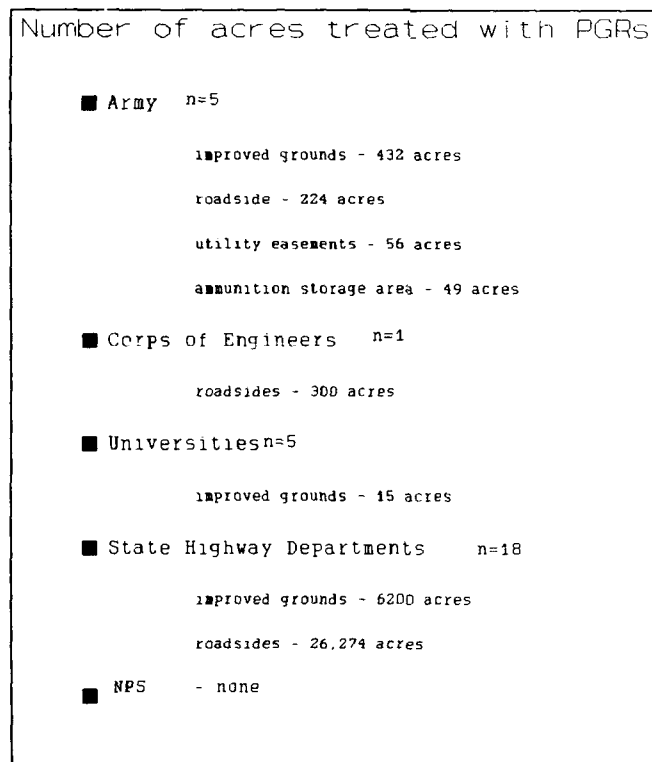


Figure 13. Actual acres being treated with plant growth regulators

74. Several reasons were given for not using PGRs. These included environmental concerns, policy restrictions, perceived ineffectiveness, unsatisfactory results, prohibitive cost, and the lack of information, application equipment, and trained applicators.

75. What are your primary purposes for using PGRs? Figure 14 illustrates that the overall use of PGRs by all agencies is for the reduction of mowing. Universities used the other category to explain their use. Their explanation for this leads to the conclusion that they are mainly being used for control of vegetation that eliminates edging, pruning, and mowing.

76. Over the past 5 years, how has the amount of acres treated with PGRs changed? As shown in Figure 15, the tendency of most agencies is toward increased use of PGRs, especially on roadsides and utility easements in the semi-improved grounds. Universities show an increase in the use of PGRs on improved grounds. The explanations given by the agencies for these changes included mowing cost reductions, weed control, and availability of a broader spectrum of PGRs from which to choose.

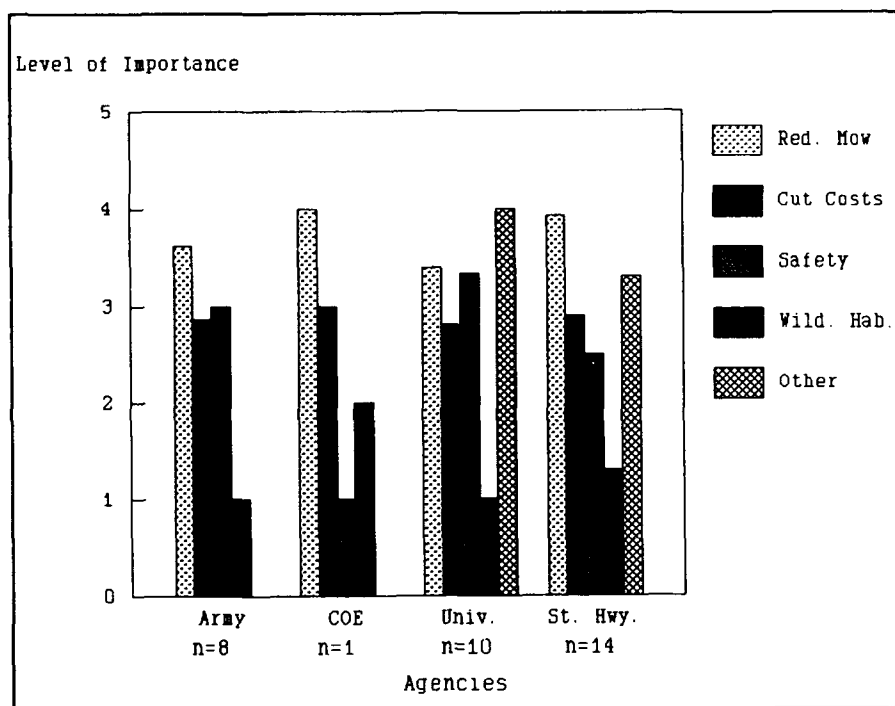


Figure 14. Reasons for using plant growth regulators

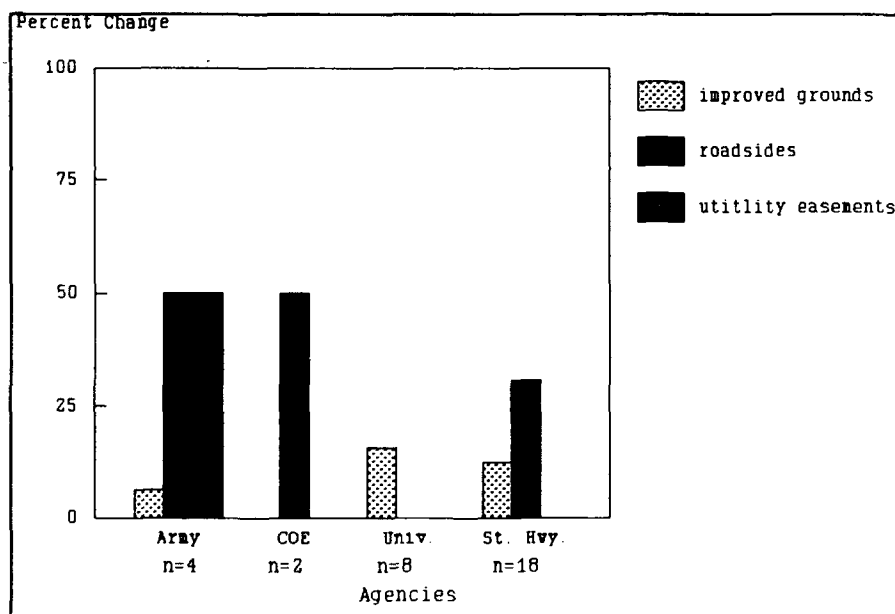


Figure 15. Percentage increase in acres treated with plant growth regulators

77. Was there any public reaction to the use of PGRs in your improved or semi-improved grounds? As shown in Figure 16, there has been little public reaction to the use of PGRs. According to the respondents, this was because the public is usually unaware of PGRs being used. However, when there was public knowledge, as one respondent stated, "in general there was a negative public response to the use of chemical control agents."

78. Was there any administrative reaction to the use of PGRs in your improved or semi-improved grounds? As illustrated by Figure 17, overall there was little administrative reaction to the use of PGRs. The Army reports a higher percentage of positive reactions than any other agency. Reasons for this included the reduction of mowing costs, increased safety for employees who mow dangerous areas less often, and improved sight distance. Negative responses included the following: undesirable use of chemicals, turf discoloration, and uneven turf appearance.

79. In your opinion, has the use of PGRs been successful in reducing your grounds maintenance costs? The vast majority of respondents from all agencies replied positively to this question. Responses were also fairly consistent as to the reasons for this positive response. Generally, the use of PGRs was considered effective for reducing mowing costs, which also allowed redistribution of labor and less wear and tear on equipment. Although the use of PGRs was considered to be successful, several respondents qualified their answers. Mention was made of such things as discoloration and reduction in turf quality and negative public response.

80. Do you use herbicides on your improved or semi-improved grounds? As shown in Figure 18, the vast majority of all agencies use herbicides. With the exception of the National Park Service, over 80 percent of the respondents use herbicides for their grounds maintenance. Within the National Park Service, 59 percent use herbicides.

81. As Figure 19 shows, although many of the NPS respondents use herbicides, their use is extremely limited, both on improved and semi-improved grounds. Quite the opposite is true of the State Highway Departments. They show a 100-percent use on improved grounds and 47-percent use on semi-improved grounds. The universities also use herbicides on a significant percentage of their acreage. The Army and Corps of Engineers use herbicides on a fairly low percentage of their grounds.

82. Of the respondents who are not using herbicides, the reasons are fairly consistent. The basic reasons are the objection to use of chemicals,

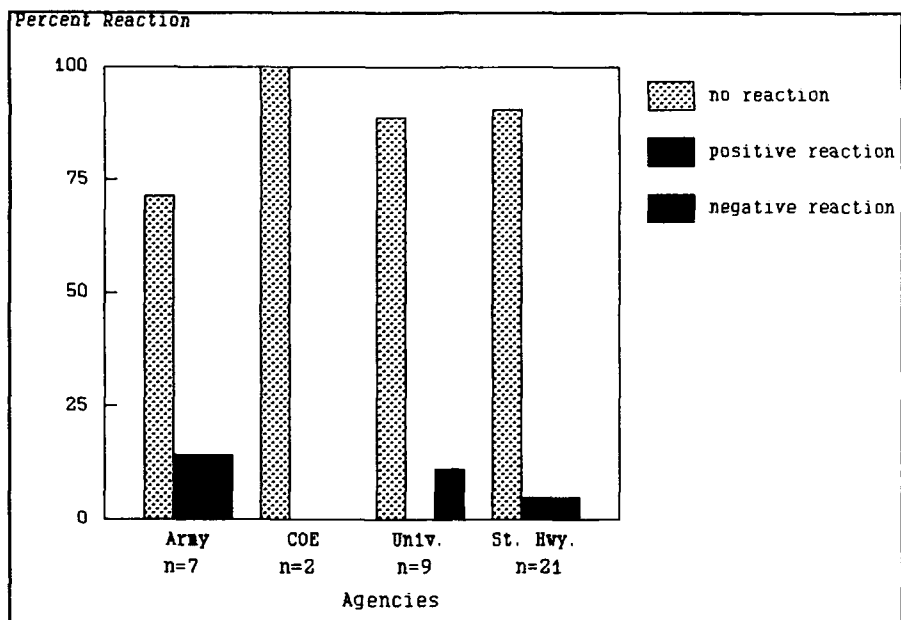


Figure 16. Public reaction to the use of plant growth regulators

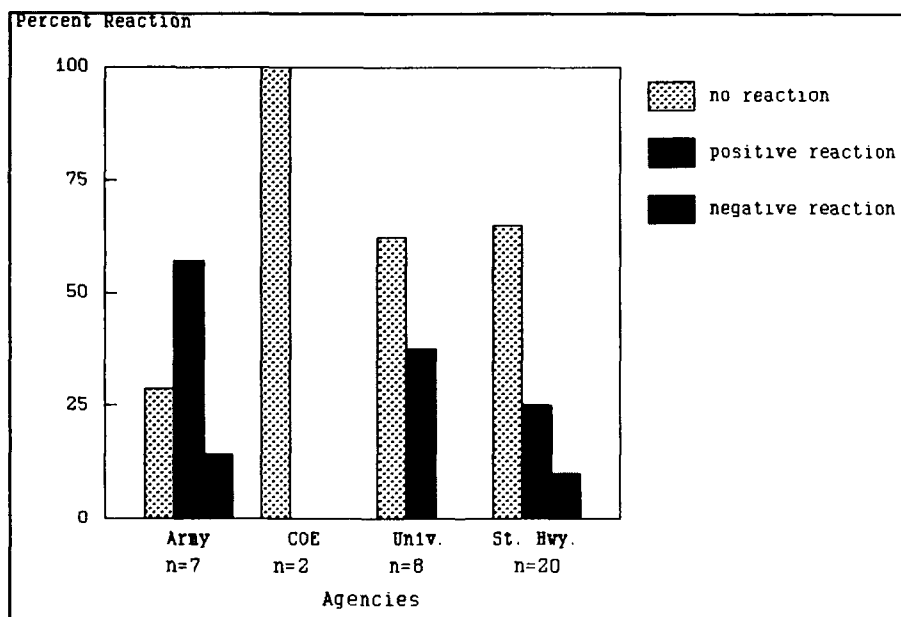


Figure 17. Administration reaction to the use of plant growth regulators

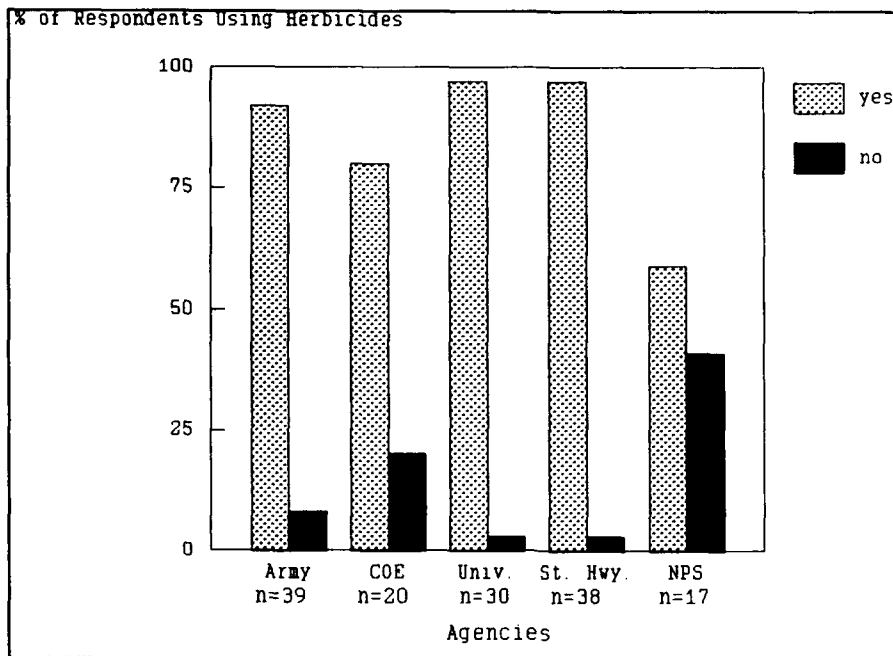


Figure 18. Percentage of respondents using herbicides

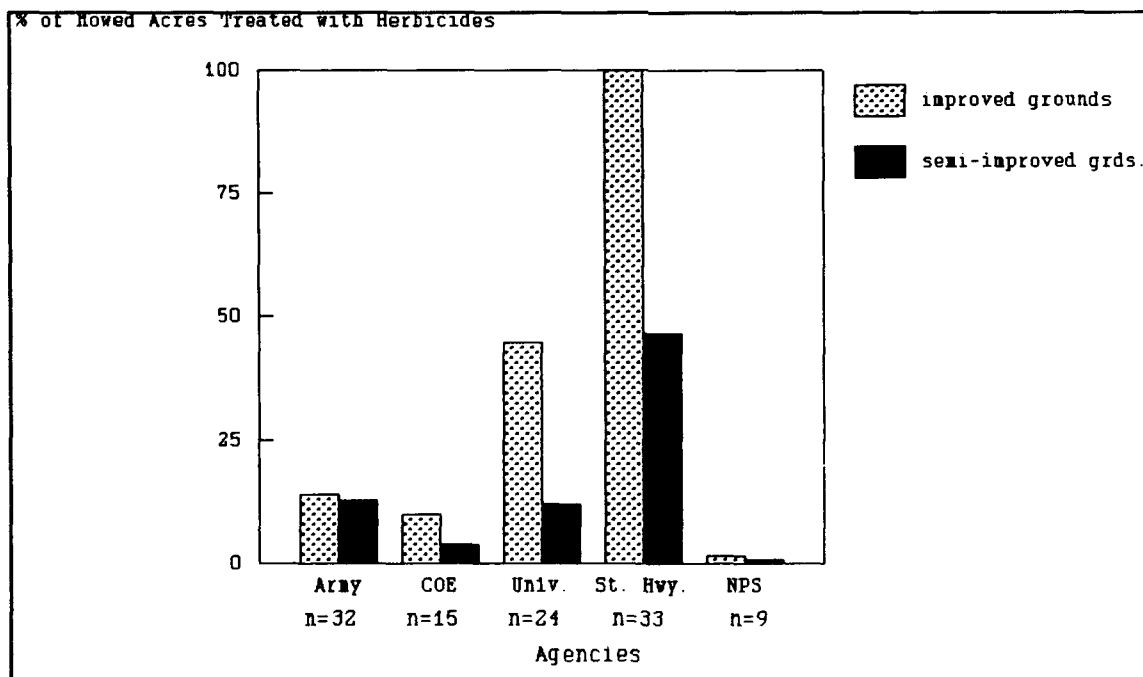


Figure 19. Percentage of mowed acres treated with herbicides

the potential harmful effects on the environment, and lack of licensed applicators. The National Park Service respondents point out that, as with PGRs, the use of herbicides is against agency policy.

83. What are your primary purposes for using herbicides? As illustrated in Figure 20, the most important use of herbicides by all agencies is for weed control. Reduction of mowing and its related costs were also significant reasons for using herbicides. Respondents also listed reasons such as reduction of trimming and edging, reduction of fire fuels, woody plant control, and for improvement of aesthetics under the "other" category.

84. Over the past 5 years, how has the amount of acres treated with herbicides changed? As shown in Figure 21, the only agencies showing a decrease in use are the National Park Service on improved grounds and the universities on semi-improved grounds. The reasons given by NPS respondents for increased usage on semi-improved grounds included the necessity to comply with county weed control board regulations and for the preparation of planting beds. It must be kept in mind when interpreting Figure 21 that any time a respondent initiates usage, that new use shows up as a 100-percent increase.

85. The Army respondents report that their relatively small increase in usage is attributable to the need to reduce mowing frequency, labor costs, and for aesthetic purposes.

86. According to State Highway Department respondents, their increased usage of herbicides is attributable to increased equipment capabilities, the desire to cut labor costs, and to comply with county board regulations.

87. Increased use of herbicides on improved grounds by universities is mainly for aesthetic purposes, to save labor, and to comply with city ordinances. Decreased use on semi-improved grounds was usually attributed to negative responses to the use of chemicals.

88. Was there any public reaction to the use of herbicides in your improved or semi-improved areas? As shown in Figure 22, the universities and State Highway Departments have had more negative reaction to the use of herbicides than the other agencies. This is not surprising in light of the fact that these are also the agencies with the highest percentage of use. This relationship also may explain why the Army, the National Park Service, and Corps of Engineers are getting almost no reaction. It can be expected there will be no reaction with little use.

89. The respondents who report negative reactions to herbicide use give environmental and health concerns as the major problem. The unpleasant

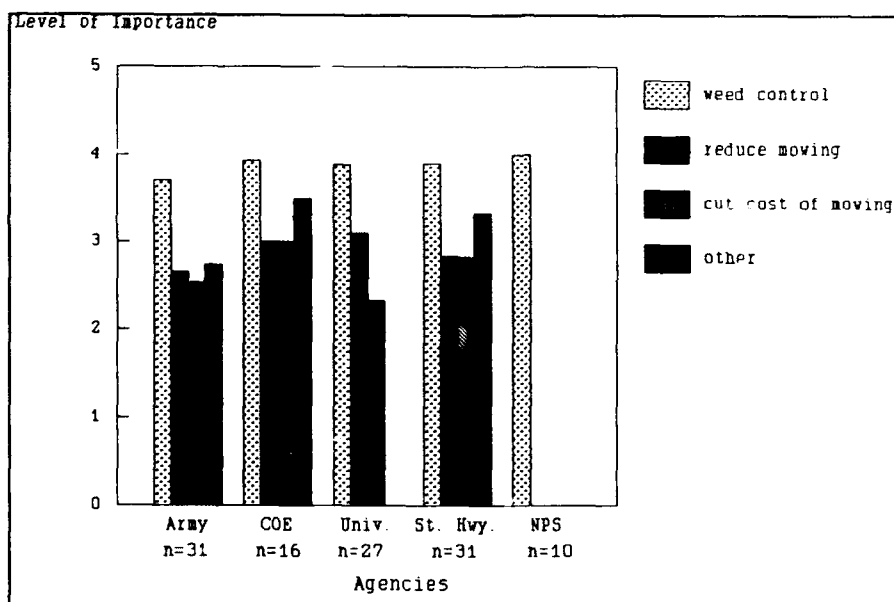


Figure 20. Reasons for using herbicides

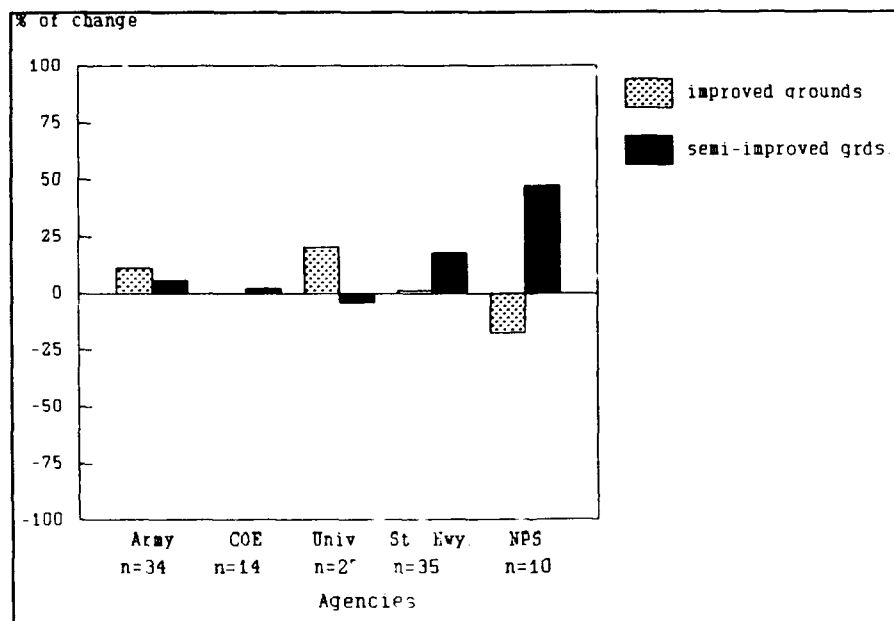


Figure 21. Percentage increase in acres treated with herbicides

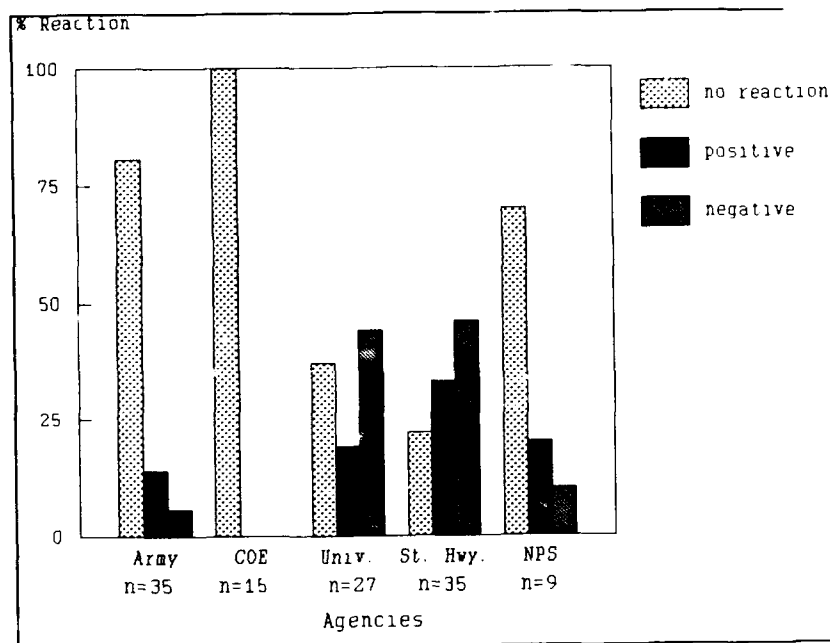


Figure 22. Public reaction to the use of herbicides

"brownout" effect caused by herbicides is another reason for complaint. On the other hand, there are positive reactions to herbicide use. The aesthetic improvement that comes from weed control is the main reason for this positive reaction.

90. Was there any administrative reaction to the use of herbicides in your improved or semi-improved areas? As illustrated in Figure 23, overall there was little negative reaction by administrators to the use of herbicides. In general, most of those using herbicides are getting no reaction or a positive reaction from administrators.

91. Positive reactions are generally attributable to the costs savings in labor and equipment and to the aesthetic improvements. When administrators object to the use of herbicides, it is usually in reaction to public outcry concerning their use. One respondent reports negative administrative reaction due to the erosion caused by herbicide use.

92. How has the use of herbicides changed your mowing costs? Over 50 percent of all respondents using herbicides report no change in mowing costs due to herbicide use. However, almost 40 percent report a decrease in overall mowing costs.

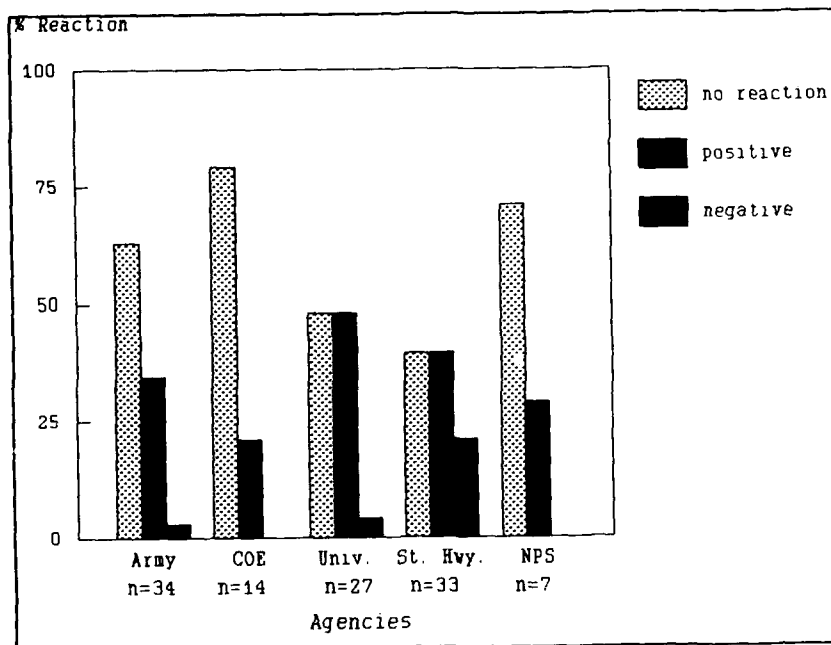


Figure 23. Administrative reaction to the use of herbicides

Category 4: Overseeding and Fertilization

93. The questions in this section were mainly for exploratory purposes. Since the objective of the study was to identify methods for cutting grounds maintenance costs, as many information-gathering questions as possible were included. Little pertinent information was revealed by the answers to this section. One respondent stated that "improper pH can affect nutrient availability to the plant, resulting in wasteful fertilizer application." Since approximately 40 percent of the respondents are not basing fertilizer application on soil sample results, this is an area with potential for cost savings.

PART V: CONCLUSIONS AND RECOMMENDATIONS

Conclusions

94. The findings of this report lead to several conclusions. First, as previously stated, the question that this report addresses is: "How does the Army compare to other public land-use agencies in its grounds maintenance standards, and practices?"

95. According to the results of the questionnaire, the answer is complex. The findings indicate that Army installations are mowing a substantially higher percentage of their area than are the other agencies. On the other hand, the Army is generally mowing at the same turf height and the same roadside footage as all the other agencies. Of all the agencies, the Army reports a higher increase over the past 5 years in the amount of its improved grounds that are being mowed. However, this seems to reflect changes in land use rather than changes in maintenance standards. The reported decrease in amount of semi-improved area being mowed by the Army may be an indication of changes in maintenance practices.

96. It is interesting to note that the Army responses indicate that their cost per acre to mow is lower than all other agencies except for the universities. This may or may not be true. Several respondents inserted notes on the questionnaire that indicated confusion as to what was to be included in their maintenance cost. Unfortunately, this leads to the conclusion that cost determination by the different respondents may not be consistent and, further, to the supposition that a proper comparison has not been made.

97. Low-maintenance vegetation is not being used by as high a percentage of Army respondents as by respondents from other agencies. Only the National Park Service reports a similar low percentage of respondent use as the Army. However, the NPS respondents frequently referred to the need to preserve historical authenticity as their reason for not changing to low-maintenance vegetation, a constraint that is not applicable to Army installations. Several Army respondents pointed out that the initial cost of establishment was prohibitive. The actual percentage of the total acreage with low-maintenance vegetation is quite low in all agencies, except the Corps of Engineers.

98. While public reaction to use of low-maintenance vegetation on Army installations seems to be similar to that of the other agencies, Army administrators show the least positive reaction when compared to all the other agencies. This can be explained by the comments made by several of the Army respondents. While one respondent mentioned that administration seems to be coming around to a more positive outlook as long as specific areas are intensely maintained, this was not the general consensus. Many Army respondents referred to the typical military attitude that desires a highly manicured look for the entire installation. Since this attitude may be standing in the way of progressive changes that would lead to lower grounds maintenance costs, an incentive program may solve the problem. Perhaps if the Community of Excellence Award were to include, as part of its criteria, the use of native vegetation, low-maintenance vegetation would become more attractive to Army Commanders.

99. Although the attitude that favors highly manicured grounds still seems to be prevalent, the Army does seem to be the leader in one innovative land use that results in lower maintenance. More Army respondents listed outleasing programs for agricultural hay harvesting than any other agency. This is especially interesting in light of the recommendations made to the Army in 1984 by a Review Team who evaluated Army natural resource management programs on military installations and civil works projects. It was recommended that the Army "reduce, where possible, the frequent mowings of large cantonment acreages and other associated open areas to curtail maintenance costs on both installations and projects." One of the ways suggested for accomplishing this was to arrange for haying licenses and/or leases. Another suggestion was for the increased use of native plants. This suggestion does not seem to have been taken as seriously as the one for haying licenses.

100. The use of PGRs by the Army for controlling grounds maintenance costs is extremely limited. Since State Highway Departments are successfully using PGRs on both improved grounds and roadsides, the Army may be able to benefit from this experience. As the literature (and several respondents) suggests, PGRs have greatly improved over the past few years. Some of the reasons cited for not using PGRs may point to a general lack of information about their effectiveness and recent improvements. It also seems evident that negative perceptions are based on experimental past use that may not be accurate in light of today's improved formulas.

101. Although the Army reports the highest percentage of positive administrative reactions of any of the agencies, it must be noted that many respondents stated that administration officials usually are not aware of PGR use. This probably explains why there is little negative reaction or no reaction at all. Since many respondents who were using PGRs found them to be effective in reducing grounds maintenance costs, the Army needs to seek more information about their use. Many respondents expressed their concern about the environmental effects of PGR use, about PGR effects on turf, and about cost effectiveness. This indicates a need for better information exchange.

102. Herbicide use by the Army is very similar to use by the Corps of Engineers, but less than use by the universities, and much less than that of State Highway Departments. The Army uses herbicides mainly for weed control and to reduce mowing costs, just as the other agencies do.

103. The Army respondents report little public or administrative reaction to their use of herbicides. The negligible amount of public reaction can probably be explained by the fact that the public rarely knows what the Army is doing within the confinement of the installations. Positive administrative reaction within the Army was attributable to improved appearance and cost savings.

104. The questionnaire elicited additional responses that suggest two other innovative techniques for lowering maintenance costs. A National Park Service respondent mentioned his use of a computerized maintenance management system for planning and evaluating maintenance practices and costs. This type of system would permit cost tracking of maintenance practices, giving grounds maintenance personnel accurate information on where funds are being spent and thus where funding cuts could best be made. An Army respondent reported a method of mapping all mowed areas, establishing criteria for areas to be mowed, and then matching areas with criteria. Areas meeting none of the criteria were designated "no-mow" areas and eliminated from the mowing cycle. These areas totaled 640 acres. These two ideas should stimulate the interest of those concerned about reducing maintenance costs.

105. Several topics for further research related to grounds maintenance were suggested by Army respondents. First, many respondents are interested in information on PGRs. Others mentioned an interest in additional information about wildflowers and soil aeration. Another interesting suggestion came from an Army respondent who commented that no questions had been asked about unimproved grounds. He states, "This program should be expanded in order to

maintain training areas. Without proper maintenance, training areas will degenerate and be incapable of providing quality training in future years."

Recommendations

Develop cost-tracking methodology

106. Cost-effectiveness is essential for determining grounds maintenance strategy. Therefore, it is important to know the cost associated with existing grounds maintenance operations. One survey reports that only 24 percent of grounds maintenance managers across the country could provide a per-acre mowing cost (Watschke, Lyman, and Prinster 1988). Managers must know where their money is being spent in order to find the most effective means of saving it.

107. The questionnaire discussed in this report attempted to determine mowing costs, costs and benefits associated with low-maintenance vegetation establishment, and the price and cost savings associated with PGRs and herbicides. However, the few cost figures that were received varied so tremendously that the validity of the figures was questionable. This lack of, and variance of, existing cost information leads us to believe that there is a need for a better understanding of the money that is being spent on various grounds maintenance practices. Development and implementation of a system to track costs of performing these activities is recommended.

Reduce mowed areas

108. This recommendation results from a practice currently under way at an Army installation. This installation mapped all mowed areas, established criteria for areas to be mowed, and then eliminated those areas not meeting the criteria. While some acreage could be eliminated from the mowing schedule, other acreage could be mowed less frequently. To realize immediate cost-saving opportunities, implementation of this type of practice is recommended at other installations.

Test cost-effectiveness of low-maintenance vegetation

109. The indications are that low-maintenance vegetation may also offer an excellent opportunity to reduce long-term costs. The findings from the questionnaire and literature review give the overall perception that the use of low-maintenance vegetation has the potential for long-term cost savings. There is, however, a lack of documented case studies that track the actual

cost savings associated with low-maintenance vegetation. It is recommended that the Army consider testing low-maintenance vegetation, using appropriate vegetative species in different geographical areas. The costs associated with establishment and maintenance of vegetation that requires minimal maintenance could be tracked and compared with existing maintenance costs. The "no-mow" concept, in which nature is allowed to take its course, has immediate cost savings and would not be tested.

Support the use of
low-maintenance vegetation

110. Army administrators should support the use of natives and natural areas, not just as a long-term means to cut grounds maintenance costs, but also to improve wildlife habitat and lessen the need for irrigation, herbicides, pesticides, and fertilizers. The Community of Excellence Program is a potential vehicle to encourage this support. A hands-on training course would be very useful for those not familiar with the most cost-effective establishment and maintenance methods for wildflowers, native grasses, and other low-maintenance vegetation. The Army should also continue its outleasing programs for agricultural hay harvesting in areas appropriate for that activity.

Provide more information on PGRs

111. The US Army Engineer Waterways Experiment Station (WES) has recently completed a 3-year study dealing primarily with the cost-effectiveness of plant growth regulators in reducing the need for mowing. Although the report is not complete, the general findings appear to be favorable, as were findings from the questionnaire discussed herein and a literature review. The Army has recently developed a "one-stop" program, where WES can provide interested Army installations with help in establishing PGR use at their installation. Army installations need further information concerning the environmental effects of PGRs and the long-term effects PGRs have on turf. The Army may benefit from State Highway Departments that have used PGRs on a sizable acreage for extended years. It is recommended that studies continue to determine fully the efficiency of PGRs and environmental impacts associated with their use.

REFERENCES

- Aungst, H. 1986 (Oct). "A Home for the Prairie," Weeds Trees & Turf, p 58.
- Beard, J. B. 1985 (Jun). "Effect of Growth Regulators on Turf," Grounds Maintenance, pp 66, 68, 70.
- Becker, R. H., Dottavio, F. D., and McDonald, B. L. 1988. "The Use of Interpretation to Gain Visitor Acceptance of Vegetation Management," Visual Preferences of Travelers Along the Blue Ridge Parkway, USDI National Park Service, Scientific Monograph Series No. 18, Washington, DC, pp 94-103.
- Bolt, M. G. 1988 (Mar). "A District Manager Looks at His Roadside Management Program," Public Works, pp 86-87.
- Buffington, J. L. 1987. Mowing, Herbicide Spraying and Litter Pickup Cost Comparisons, Research Report 380-1F, Vol 2, p 66, Texas Transportation Institute, Texas A&M University System, College Station, TX.
- Carr, S. 1985. "Limit PGR Applied at Historic Cemeteries," ALA Technology, Vol 6, No. 4, pp 32-33.
- Colbert, R. A. 1983 (Apr). "Beautifying Median Strips," Grounds Maintenance, pp 34-35, 38.
- Constructor. 1988 (May). "Wildflowers: Functional Beauty," pp 16-18.
- Creekmur, L. 1987 (Jul). "Plant Prairies with Color," Grounds Maintenance, p 58.
- Danneberger, T. K., and Street, J. R. 1986. "PGRs for Highway Turf," Weeds Trees & Turf, Vol 25, No. 6, pp 40-42, 46.
- Diekelmann, J., and Schuster, R. 1982. Natural Landscaping, McGraw-Hill, New York, pp 1-8.
- Doll, J. D. 1988 (Mar). "Roadside Weeds: A Constant Challenge," Public Works, pp 78-80.
- Dusablon, C. A. 1988 (Mar). "Renewed Interest Spurs Wildflower Research in Vermont," Public Works, pp 56-58.
- Freeborg, R. P. 1983 (Jun). "Growth Regulators," Weeds Trees & Turf, pp 46-48.
- Hagman, J. 1983. "Growth Regulators Can Cut Maintenance Costs," Park Maintenance and Grounds Management, Vol 36, No. 1, pp 12-14.
- Jett, C. 1988 (Sept). "Missouri's New Vegetation Management Program," Public Works, pp 99-101.
- Kaufmann, J. E. 1985. "Winning with Turfgrass Growth Regulators," ALA Technology, Vol 6, No. 4, pp 31-39.
- Kaufmann, J. E. 1986 (May). "Growth Regulators for Turf," Grounds Maintenance, pp 72, 74, 76, 78, 80.
- Kerr, J. 1979 (Oct). "Park Supervisors Adjust To Financial Pressures," Weeds Trees & Turf, pp 14, 17-18, 53.
- Kuennen, T. 1986a (Feb). "Native Flowers, Grasses Find Favor Among States," Roads & Bridges, pp 52-55.
- Kuennen, T. 1986b (Feb). "Use Right Herbicide for Each Application," Roads & Bridges, pp 32-33, 36.

- Leslie, C. 1986 (Mar). "America Wildly Aflower," Reader's Digest.
- Meyer, W. A. 1989 (Apr). "Low-Maintenance Turf," Grounds Maintenance, pp 68, 70, 74, 139.
- Morre', D. J. Undated. "New Program of Chemical Mowing Along Indiana Road-sides," Transportation Research Record 913, pp 16-18.
- Newman, Herb. Undated. "Wildflower Propagation," Texas State Highway Department, pp 1-5.
- Orndorff, C. 1986 (May). "Flowers Add Zest to Ground Covers," Grounds Main-tenance, pp 67-73.
- Park Maintenance and Grounds Management. 1982. "Golf Course Mowing Cut By Growth Retardant," Vol 35, No. 4, pp 18-19.
- Park Maintenance and Grounds Management. 1985. "Howard County Parks Try Growth Regulator," Vol 38, No. 12, pp 14-15.
- Park Maintenance and Grounds Management. 1986. "Wildflowers, A Low-Cost Alternative," Vol 39, No. 6, p 4.
- Percy, D. 1985 (Jan). "Cost Cutting Canopies," GC & HTJ, pp 25-27.
- Pointer, J. 1986. "Ground Covers Can Help Your Landscaping," Park Main-tenance and Grounds Management, Vol 39, No. 6, pp 8, 10.
- Prairie Restorations, Inc. 1989. "A Statement of Purpose, Services and Products," Princeton, MN.
- Roads and Bridges. 1986 (Feb). "How It's Done, Coast-To-Coast," pp 42-44.
- Rolfes, S., Lazor, R. L., Smith, R., and Allen, H. H. 1989 (Feb). "Low-Maintenance Prairie Restoration Demonstration at Saylorville Lake," RECNOTES, Vol R-89-1, US Army Engineer Waterways Experiment Station, Vicksburg, MS, pp 1-5.
- State of Texas. 1988. "Standards of Vegetation Management," Department of Highways & Public Transportation, Austin, TX, p 22.
- Steinegger, D. H., and Todd, K. W. 1979 (May). "Groundcovers Provide Alter-native to Turfgrass in Landscaping," Weeds Trees & Turf, pp 38-39, 42-43, 66, 68, 70, 72, 74.
- Stroud, T. 1986 (Apr). "Low-Maintenance Turf Alternatives," Grounds Main-tenance, pp 10, 16, 18, 118.
- Stroud, T. 1989 (Jan). "Rough and Wild: Using Wildflowers On Golf Courses," Grounds Maintenance, pp 28, 30, 32, 36.
- Tiller, K., Newman, G., and Dennis, L. 1984 (May). "Give the Land Back to the Natives," Grounds Maintenance, pp 25-26, 28, 72.
- Wade, G. 1986. "Low Maintenance Landscaping from Design to Management," Park Maintenance and Grounds Management, Vol 39, No. 9, pp 4-7.
- Watschke, T. L., Lyman, G., and Prinster, M. 1988 (Jul). "Using PGRs Along Roadsides," Grounds Maintenance, pp 14, 16.
- Webster, A. H. 1975 (Feb). "Prairie Grasses, the Vista-Makers," Weeds Trees & Turf, pp 18, 34-35.
- Weeds Trees & Turf. 1986. "Miles to Go," Vol 25, No. 6, pp 26, 28.

Wilcox, A. T., ed. 1983. Design For Maintenance: A Park Management Aid.
National Recreation and Park Association and USDI, National Park Service,
Washington, DC, pp 70-71.

APPENDIX A: GROUNDS MAINTENANCE QUESTIONNAIRE

Grounds Maintenance Questionnaire

The U.S. Army Engineering and Housing Support Center is concerned about the rising cost of grounds maintenance at Army installations. In an effort to find ways to reduce these costs, the U.S. Army Engineer Waterways Experiment Station is currently conducting a study to determine grounds maintenance standards and practices being used by various agencies and organizations.

This questionnaire has been designed to provide information needed for the study. While most of the questions can be answered by your grounds maintenance division, some of the information may need to come from your landscape design section.

The questionnaire includes questions concerning both improved and semi-improved grounds. Some of the types of areas within these categories may not apply to your situation. Therefore, please answer the questions that pertain to your particular operation.

Improved grounds include both high and low intensity use areas. High intensity use areas include parade grounds, drill fields, intramural athletic fields, and similar areas (golf courses are excluded from this study). Low intensity use areas are those with a lower level of use, such as lawn areas around buildings, visitor centers, and adjacent areas where attractive appearance is important.

Semi-improved grounds include areas which require recurring maintenance but to a lesser degree than on improved grounds. This category includes such areas as roadsides, open areas (peripheral to roadsides or improved grounds), utility easements, developed picnic areas, developed camping areas, firebreaks, clear zones, airfields, and ammunition storage areas.

Thank you very much for your time and effort used in answering the questionnaire. Any additional suggestions or recommendations are greatly appreciated.

Name of Respondent(s)

Address

Phone Number

Conventional Mowing

1. Please answer the following questions about conventional mowing in your improved and semi-improved grounds.

	<u>Improved Grounds</u>				<u>Semi-Improved Grounds</u>						
	high intensity	low intensity	roadside	open areas	utility easements	developed picnic areas	developed camping areas	firebreaks	clear zones	airfields	other
- Approximately how many total acres are you currently responsible for maintaining?											
- How many of these acres are presently mowed?											
- Do you mow on the basis of:											
a. frequency (list frequency by number of day cycle, e.g. 7 day cycle)											
and/or											
b. maintaining a set height of vegetation (list height in inches)											
- What is the average number of mowings per year?											
- What is the approximate cost to mow per acre?											

2. How many feet from the shoulder of the road is the roadside mowed? _____ ft.

3. Has the amount of area mowed changed in the past 5 years? Please indicate the percentage of change.

<u>Improved grounds</u>	high intensity	☐ no change	☐ % increase	☐ % decrease
	low intensity	☐ no change	☐ % increase	☐ % decrease
<u>Semi-improved grounds</u>	roadside	☐ no change	☐ % increase	☐ % decrease
	open areas	☐ no change	☐ % increase	☐ % decrease
	utility easements	☐ no change	☐ % increase	☐ % decrease
	picnic areas	☐ no change	☐ % increase	☐ % decrease
	camping areas	☐ no change	☐ % increase	☐ % decrease
	firebreaks	☐ no change	☐ % increase	☐ % decrease
	clear zones	☐ no change	☐ % increase	☐ % decrease
	airfields	☐ no change	☐ % increase	☐ % decrease
	other _____	☐ no change	☐ % increase	☐ % decrease
	other _____	☐ no change	☐ % increase	☐ % decrease

Please explain why these changes have taken place.

A6

4. Has the frequency of mowing changed in the past 5 years? Please indicate the percentage of change.

<u>Improved grounds</u>	high intensity	☐ no change	☐ % increase	☐ % decrease
	low intensity	☐ no change	☐ % increase	☐ % decrease
<u>Semi-improved grounds</u>	roadside	☐ no change	☐ % increase	☐ % decrease
	open areas	☐ no change	☐ % increase	☐ % decrease
	utility easements	☐ no change	☐ % increase	☐ % decrease
	picnic areas	☐ no change	☐ % increase	☐ % decrease
	camping areas	☐ no change	☐ % increase	☐ % decrease
	firebreaks	☐ no change	☐ % increase	☐ % decrease
	clear zones	☐ no change	☐ % increase	☐ % decrease
	airfields	☐ no change	☐ % increase	☐ % decrease
	other _____	☐ no change	☐ % increase	☐ % decrease
	other _____	☐ no change	☐ % increase	☐ % decrease

Please explain why these changes have taken place.

5. Are you using any other treatment in place of, or in conjunction with, mowing (e.g. burning, etc.)?

Please describe the treatment, where it was used, and why it was used.

6. Additional comments.

Low Maintenance Vegetation

7. Do you use low maintenance vegetation (e.g. ornamental ground covers, wildflowers, native grasses, native shrubs, native trees) in your improved or semi-improved grounds?

☐ yes

☐ no (Please explain why not):

(Go to Question 14).

Is this currently an experimental or established use?

☐ experimental use _____ number of years

☐ established use _____ number of years

8. What are your primary purposes for using the low maintenance vegetation (number all that apply in the order of importance with 1 being the most important)?

_____ reduce mowing

_____ aesthetics

_____ wildlife habitat improvement

_____ cut cost of mowing

_____ aid in erosion control

_____ other (please specify) _____

9. Please answer the following questions about low maintenance vegetation in your improved and semi-improved grounds.

	Improved Grounds		Semi-Improved Grounds									
	high intensity	low intensity	roadside	open areas	utility easements	developed picnic areas	developed camping areas	firebreaks	clear zones	airfields	other	
How many acres of low maintenance vegetation are you using?												
What type of low maintenance vegetation are you using?												
How many years did it take for the plants to become established?												
Approximately, what is the cost, per acre, to establish your low maintenance vegetation?												
How has the low maintenance vegetation changed your mowing costs (increased or decreased)												
How much per year?												
By what percentage has mowing been reduced?												

10. Over the past 5 years, has the amount of acres in low maintenance vegetation changed? Please indicate the percentage of change.

<u>Improved grounds</u>	high intensity	☐ no change	☐ % increase	☐ % decrease
	low intensity	☐ no change	☐ % increase	☐ % decrease
<u>Semi-improved grounds</u>	roadsides	☐ no change	☐ % increase	☐ % decrease
	open areas	☐ no change	☐ % increase	☐ % decrease
	utility easements	☐ no change	☐ % increase	☐ % decrease
	picnic areas	☐ no change	☐ % increase	☐ % decrease
	camping areas	☐ no change	☐ % increase	☐ % decrease
	firebreaks	☐ no change	☐ % increase	☐ % decrease
	clear zones	☐ no change	☐ % increase	☐ % decrease
	airfields	☐ no change	☐ % increase	☐ % decrease
	other _____	☐ no change	☐ % increase	☐ % decrease
	other _____	☐ no change	☐ % increase	☐ % decrease

Please explain why these changes have taken place.

11. Was there any public reaction to these changes? ☐ no reaction ☐ positive ☐ negative

Please explain.

12. Was there any administrative reaction to these changes? ☐ no reaction ☐ positive ☐ negative

Please explain.

13. In your opinion, has the use of low maintenance vegetation been successful in reducing your grounds maintenance costs? Please explain.

Plant Growth Regulators (PGRs)

14. Do you use PGRs in your improved or semi-improved grounds?

☐ yes ☐ no (Please explain why not: _____)

(Go to question 21).

Is this currently an experimental or established use?

☐ experimental use ____ number of years
☐ established use ____ number of years

15. What are your primary purposes for using PGRs (number all that apply in order of importance, with 1 being the most important)?

____ reduce mowing ____ wildlife habitat improvement ____ other (please specify) _____
 ____ cut cost of mowing ____ safety (e.g. reducing mowing in airfields) _____

16. Please answer the following questions about the use of PGRs in your improved or semi-improved grounds.

Improved Grounds

	high intensity	low intensity	roadside	open areas	utility easements	developed picnic areas	developed camping areas	firebreaks	clear zones	airfields	other
How many acres are treated with PGRs?											
How frequently are PGRs applied (every ____ months)?											
Approximately, how much does it cost, per acre, to apply PGRs?											
How has the use of PGRs changed your mowing costs (increased or decreased)?											
How much per year?											
By what percentage has mowing been reduced?											

Semi-Improved Grounds

17. Over the past 5 years, how has the amount of acres treated with PGRs changed? Please indicate the percentage of change.

<u>Improved grounds</u>	high intensity	☐ no change	☐ % increase	☐ % decrease
	low intensity	☐ no change	☐ % increase	☐ % decrease
<u>Semi-improved grounds</u>	roadsides	☐ no change	☐ % increase	☐ % decrease
	open areas	☐ no change	☐ % increase	☐ % decrease
	utility easements	☐ no change	☐ % increase	☐ % decrease
	picnic areas	☐ no change	☐ % increase	☐ % decrease
	camping areas	☐ no change	☐ % increase	☐ % decrease
	firebreaks	☐ no change	☐ % increase	☐ % decrease
	clear zones	☐ no change	☐ % increase	☐ % decrease
	airfields	☐ no change	☐ % increase	☐ % decrease
	other _____	☐ no change	☐ % increase	☐ % decrease
	other _____	☐ no change	☐ % increase	☐ % decrease

Please explain why these changes have taken place.

18. Was there any public reaction to the use of PGRs in your improved or semi-improved grounds? ☐ no reaction ☐ positive ☐ negative

Please explain.

19. Was there any administrative reaction to the use of PGRs in your improved or semi-improved grounds? ☐ no reaction ☐ positive ☐ negative

Please explain.

20. In your opinion, has the use of PGRs been successful in reducing your grounds maintenance costs? Please explain.

Herbicides

21. Do you use herbicides on your improved or semi-improved grounds?

☐ yes ☐ no (Please explain why not: _____)

(Go to question 26).

What are your primary purposes for using herbicides (number all that apply in the order of importance, with 1 being the most important?)

_____ weed control _____ cut cost of mowing _____ other (please specify) _____

_____ reduce mowing _____

22. Please answer the following questions on the use of herbicides in your improved or semi-improved grounds.

Improved Grounds

Semi-Improved Grounds

high intensity	low intensity	roadside	open areas	utility easements	developed picnic areas	developed camping areas	firebreaks	clear zones	airfields	other

- How many acres are treated with herbicides?

- How frequently are herbicides applied (every ___ months)?

- Approximately, how much, per acre, does it cost to apply herbicides?

- How has the use of herbicides changed your mowing costs (increased or decreased)?

How much per year?

- By what percentage has mowing been reduced?

23. Over the past 5 years, how has the amount of acres treated with herbicides changed? Please indicate the percentage of change.

<u>Improved grounds</u>	high intensity	☐ no change	☐ % increase	☐ % decrease
	low intensity	☐ no change	☐ % increase	☐ % decrease
<u>Semi-improved grounds</u>	roadside	☐ no change	☐ % increase	☐ % decrease
	open areas	☐ no change	☐ % increase	☐ % decrease
	utility easements	☐ no change	☐ % increase	☐ % decrease
	picnic areas	☐ no change	☐ % increase	☐ % decrease
	camping areas	☐ no change	☐ % increase	☐ % decrease
	firebreaks	☐ no change	☐ % increase	☐ % decrease
	clear zones	☐ no change	☐ % increase	☐ % decrease
	airfields	☐ no change	☐ % increase	☐ % decrease
	other _____	☐ no change	☐ % increase	☐ % decrease
	other _____	☐ no change	☐ % increase	☐ % decrease

Please explain why these changes have taken place. _____

A13

24. Was there any public reaction to the use of herbicides in your improved or semi-improved areas? ☐ no reaction ☐ positive ☐ negative

Please explain. _____

25. Was there any administrative reaction to the use of herbicides in your improved or semi-improved areas? ☐ no reaction ☐ positive ☐ negative

Please explain. _____

Overseeding and Fertilization

26. Do you overseed your improved or semi-improved grounds?

☐ yes ☐ no (Please explain why not: _____)

(Go to question 28).

What are your primary purposes for overseeding (number all that apply in order of importance, with 1 being most important)?

_____ damaged turf _____ aesthetics _____ traditional practice _____ other (please specify) _____

27. How many acres and how often do you overseed each year:

Improved grounds

high intensity
low intensity

_____ acres _____ months
_____ acres _____ months

Semi-improved grounds

roadsides
open areas
utility easements
picnic areas
camping areas
firebreaks
clear zones
airfields
other _____
other _____

_____ acres _____ months
_____ acres _____ months
_____ acres _____ months
_____ acres _____ months
_____ acres _____ months
_____ acres _____ months
_____ acres _____ months
_____ acres _____ months
_____ acres _____ months
_____ acres _____ months

28. Do you fertilize your improved or semi-improved grounds?

☐ yes ☐ no (Please explain why not: _____)

(Go to question 32).

What are your primary purposes for fertilizing (number all that apply in order of importance, with 1 being most important)?

_____ healthier turf _____ aesthetics (e.g. color) _____ traditional practice _____ other (please specify) _____

29. How many acres and how often do you fertilize each year:

<u>Improved grounds</u>	high intensity low intensity	_____ acres _____ acres	every _____ months every _____ months
<u>Semi-improved grounds</u>	roadsides open areas utility easements picnic areas camping areas firebreaks clear zones airfields other _____	_____ acres _____ acres _____ acres _____ acres _____ acres _____ acres _____ acres _____ acres _____ acres	every _____ months every _____ months every _____ months every _____ months every _____ months every _____ months every _____ months every _____ months every _____ months

30. How often are soil samples taken and tested? every _____ year(s)

31. Are fertilizers and application rates based on soil samples? ☐ yes ☐ no

Please explain. _____

Summary

32. Additional comments. _____

33. What areas regarding grounds maintenance do you think need further research? _____