



# JOINT HIGHWAY RESEARCH PROJECT

JHRP-76-31

A 5-YEAR EVALUATION OF HIGHWAY  
MOWING PRACTICES: SUMMARY  
AND RECOMMENDATIONS

D. James Morre  
Jane Eberle





Interim Report

A 5-YEAR EVALUATION OF HIGHWAY MOWING PRACTICES:  
SUMMARY AND RECOMMENDATIONS

TO: J. F. McLaughlin, Director December 1, 1976  
Joint Highway Research Project  
Project: C-36-48F

FROM: H. L. Michael, Associate Director  
Joint Highway Research Project File: 9-5-6

The attached Interim Report is on the HPR Part II Study titled "Low-Cost Maintenance Program for Indiana Roadsides". The Report is titled "A 5-Year Evaluation of Highway Mowing Practices: Summary and Recommendations". It has been authored by Professor D. James Morre and Ms. Jane Eberle, Department of Biological Sciences, Purdue University.

The Report summarizes the results of research directed at evaluation of mowing practices and recommends mowing practice for the state to minimize costs and maintain safety and appearance.

The Report is submitted as partial fulfillment of the objectives of this Study. Upon acceptance by the Board it will be submitted to ISHC and FHWA for review and similar acceptance.

Respectfully submitted,

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SUMMARY AND RECOMMENDATIONS

by

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and

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Joint Highway Research Project

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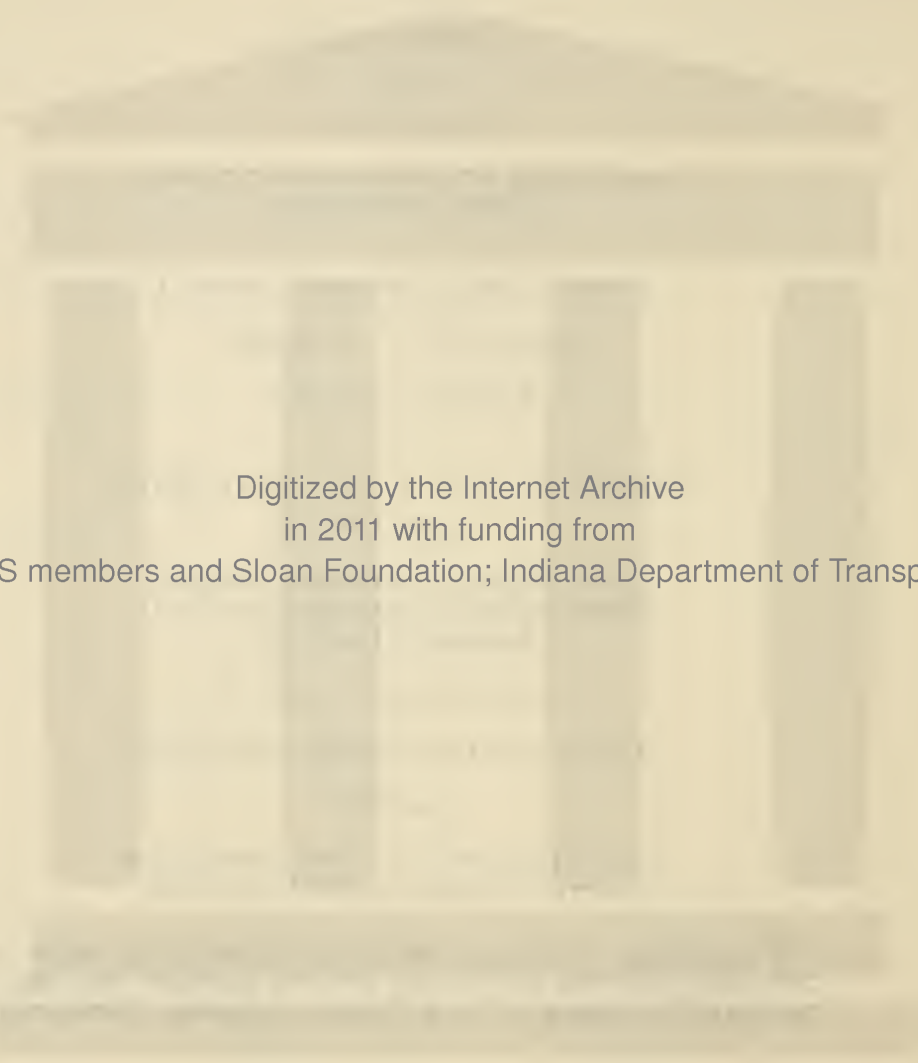
Joint Highway Research Project  
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in cooperation with the  
Indiana State Highway Commission  
and the

U.S. Department of Transportation  
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The opinions, findings and conclusions expressed in  
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16. Abstract A 5-year evaluation of roadside mowing practices in the State of Indiana is presented. Findings show that the first mowing cycle is the most critical. This mowing if done too early is wasted because the most rapid grass growth occurs in early spring. If carried out too late or when the grass is wet, it becomes injurious to the turf due to piling up of grass and smothering. The optimum height for the first mowing cycle is between 18 and 24 inches. To prevent scalping and to avoid piling up and smothering of grass, the minimum height should be increased to 5 or 6 inches depending on the number of cycles. The second cycle of 3-cycle mowing is less critical and could be eliminated most seasons if the first cycle were delayed. The last cycle should be delayed so that no more than about 12 inches of growth occurs before winter. This leaves the roads with a well maintained appearance during the winter months and with enough growth to protect the grass from winter killing but not so much growth that the fall-spring spraying for control of broad-leaf weeds is interfered with.  Unmowed roadsides remained in good condition over the 5-year observation period. A major problem is that brush begins to take over in many areas. Addition of a brush control agent to the fall-spring spraying rotation for these areas is indicated or 1-cycle mowing (mid July to mid August) at least every other year.					
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SUMMARY

A 5-year evaluation of roadside mowing practices in the State of Indiana is presented. Findings show that the first mowing cycle is the most critical. This mowing if done too early is wasted because the most rapid grass growth occurs in early spring. If carried out too late or when the grass is wet, it becomes injurious to the turf due to piling up of grass and smothering. The optimum height for the first mowing cycle is between 18 and 24 inches. To prevent scalping and to avoid piling up and smothering of grass, the minimum height should be increased to 5 or 6 inches depending on the number of cycles. The second cycle of 3-cycle mowing is less critical and could be eliminated most seasons if the first cycle were delayed. The last cycle should be delayed so that no more than about 12 inches of growth occurs before winter. This leaves the roads with a well maintained appearance during the winter months and with enough growth to protect the grass from winter killing but not so much growth that the fall-spring spraying for control of broad-leaf weeds is interfered with.

Frequent transgressions by contract mowers include failure to adequately trim around poles, signs, guard rails and culvert as well as leaving uncut strips between mowing swaths. Most are due to carelessness and inconsistent inspection. Scalping and piling up of mowed grass are more serious since both result in loss of established turf. To prevent scalping, we suggest that the minimum mowing height be raised. This will also reduce piling up. Mowing of wet grass should be prohibited.

Unmowed roadsides remained in good condition over the 5-year observation period. A major problem is that brush begins to take over in many areas. Addition of a brush control agent to the fall-spring spraying rotation for these areas is indicated or 1-cycle mowing (mid July to mid August) at least every other year.



## INTRODUCTION

Conservative estimates of the areas from the outside of the shoulders to the farthest boundary of the right-of-way subject to some type of vegetation management yield figures suggesting that approximately 75,000 acres of roadside in Indiana are presently included in some phase of either a contract spraying or mowing program. One mile of a typical Interstate route may have over 20 acres to maintain. Since the cost of roadside mowing normally exceeds \$25 per acre per season, even with reduced mowing due to effective weed control, the potential magnitude for cost savings in roadside mowing are considerable.

In 1970, the Indiana State Highway Department changed from a 5-cycle contract mowing program to reduce costs and to conserve energy. This reduction in the number of mowings was made possible in large measure because of effective weed control through the contract spraying program.

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

- 1) To identify unnecessary mowing cycles so that additional cycles might be eliminated.
- 2) To schedule those mowing cycles which provide the most benefit at times when they most contribute to the effectiveness of the Fall-Spring Roadside Spraying Program.
- 3) To evaluate reduced or limited mowing practices, including unmowed areas, to determine deleterious effects on turf or other undesirable features.
- 4) To inspect actual mowing operations to determine how mowing practices might be improved to enhance appearance and efficiency, to minimize mowing acreage, and optimize the production of a healthy turfed roadside.

METHODS OF PROCEDURE

Mowing evaluations were based on uniform test plots established as part of this research project, regular unscheduled inspections of contract mowing state-wide, roadside areas for which accurate mowing histories were available, and information from other states and countries.

Uniform test plots.--Uniform test plots were established in the spring of 1973 on I-74, in the Crawfordsville Subdistrict along the west-bound lane approximately one mile west of Crawfordsville, on State Road 28, in the Veedersburg Subdistrict on the southside of the road approximately 3/4 mile from the junction with State Road 25 and along State Road 126 in Tippecanoe County. Each 1 mile long test area was divided into four sub-plots (Table 1, Fig. 1, Fig. 2):

- 1) SECTION I, DO NOT MOW (unmowed)
- 2) SECTION II, 1 CYCLE (summer mowing only)
- 3) SECTION III, 2 CYCLE (spring and fall mowing only)
- 4) SECTION IV, 3 CYCLE (spring, summer and fall mowing).

Mowing dates selected were:

SPRING: June 20 to July 8

SUMMER: August 4 to August 18

FALL: September 22 to October 8

The sections in the test plots were mowed to the fence rather than to the ditch plus 5 feet. All mowing operations were by district personnel. At the state level, Melvin Calvert and Marion Bugh of the Landscape Division Indiana State Highway Department assisted with administrative affairs. At the district level, Kelsey McDaniel, Ed Kirkpatrick, and Don Bickel of Crawfordsville and Kelley Little of Veedersburg assisted in establishing and maintaining the test plots.

Don Bickel, and especially Ed Kirkpatrick, were most helpful in contacting maintenance crews at the proper times. Personnel with the maintenance crews were also very helpful.

Table I

SAMPLE UNIFORM MOWING TEST PLOT

Location: Crawfordsville Sub-district, along the west-bound lane of Interstate-74 approximately one mile west of the I-74 and U.S. 231 interchange.

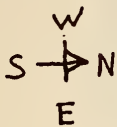
Description: There are four (4), mowing test plots in this experiment which are labeled as follows:

- 1) SECTION I, DO NOT MOW
- 2) SECTION II, cycle 1
- 3) SECTION III, cycle 2
- 4) SECTION IV, cycle 3

Schedule: Mow section III and section IV in late June, early July (June 20 to July 8).  
 Mow section II and section IV in early August (August 4 to 18).  
 Mow section III and section IV in late September or early October (September 22 to October 8)

Notes: In each section the area to be mowed is from the roadside to the fence row.

Map:



Median

I-74  
(paved)

End mowing test

Section IV  
Cycle 3

(spring, summer and fall mowing)

Section III  
cycle 2

(Spring and Fall mowing)

Section II  
Cycle 1

(Summer mowing)

Section I  
DO NOT mow

(leave unmowed)

Begin mowing test plots

signs

signs

Fence row

signs

signs

signs



Fig. 1. Uniform mowing test plots in Veedersburg Subdistrict. Photographed on June 11, 1974, at time of first mowing.



Fig. 2. Uniform mowing test plots in Crawfordsville Subdistrict. Photographed in late June after first mowing.



Inspections of contract mowing.--Biweekly inspections of contract mowing operations were made each summer beginning in 1972 at various locations throughout the state. The following observations were made (Table II) for each location.

Average grass height

Date and grass height at time of mowing

Overall appearance

Evidence of scalping, piling up or skips

Weather conditions especially at time of mowing

Photographs were taken to document major observations.

Evaluations of roadside areas where accurate mowing histories were available.

Areas in interchanges on various Interstate Systems were utilized heavily to evaluate effects of reduced mowing on turf. Some of these areas are now entering their 6th and 7th years of non-maintenance except for chemical weed control. Clyde Mason of the Greenfield Subdistrict was especially helpful in bringing such areas to our attention and in providing accurate mowing histories.

Information from other states and countries.--Based on published mowing practices and limited inspections, comparisons on the Indiana mowing program were made with those in Illinois, Michigan, Ohio, Missouri and New York. Additionally, evaluations of mowing practices in Central Europe were made in 1975 while the project director was on sabbatical leave from Purdue University. These latter comparisons were especially helpful since limited mowing is rather generally practiced in most parts of Europe.



TABLE II

MOWING INSPECTION REPORT

Joint Highway Research Project, Purdue University

Date of inspection \_\_\_\_\_ Inspector (name) \_\_\_\_\_

Day Month Year

Road \_\_\_\_\_ Direction (E)(W)(N)(S) From \_\_\_\_\_ To \_\_\_\_\_

Predominant grass species \_\_\_\_\_

MOWED PORTION: (Unmowed)(to ditch)(to ditch plus 5 ft)(to fence)(other)

Explain \_\_\_\_\_

Height in inches \_\_\_\_\_ Range: \_\_\_\_\_ to \_\_\_\_\_ % with seed heads \_\_\_\_\_

UNMOWED PORTION: Ht \_\_\_\_\_ Range: \_\_\_\_\_ to \_\_\_\_\_ % with seed heads \_\_\_\_\_

Weather at time of inspection: Temp (°F) \_\_\_\_\_ Moisture (raining)(wet) (moderately wet)(average)(moderately dry)(dry)(very dry)

Highway safety:  
Approximate sight distance at intersections (feet) \_\_\_\_\_

Weed information: Species visible at normal driving speeds and height above grass (in inches)

Approximate sight distance on inside of curves (feet) \_\_\_\_\_

Guard rails, signs and other traffic control devices open to view (Yes)(NO) \_\_\_\_\_  
Explain: \_\_\_\_\_

Evidence of:

Skips (Yes)(No) Comments: \_\_\_\_\_

Piling up (Yes)(No) Comments: \_\_\_\_\_

Scalping (Yes)(No) Comments: \_\_\_\_\_

Overall appearance:

MOWED PORTION (attractive)(good)(fair)(poor)(very poor) Explain:

UNMOWED PORTION (distracting)(not objectionable)(attractive) Explain:

Bruch: (No./100 ft) \_\_\_\_\_ Ave Height (feet) \_\_\_\_\_ Species

present: \_\_\_\_\_

Mowing in progress at time of inspection (Yes)(No) Comments \_\_\_\_\_

\_\_\_\_\_ Condition of grass (raining)(grass wet)(grass dry)

Name of contractor \_\_\_\_\_ Chief operator \_\_\_\_\_

With whom did you speak (name)? \_\_\_\_\_

Comments including equipment and personnel (use reverse side if necessary):

OBSERVATIONS

Uniform Mowing Tests: Other than appearance during the growing season, we have yet to observe any differences due to 1-, 2- or 3-cycle mowing on the Interstate System. In all three types of maintenance, grass remains healthy. Here the predominant grass species is smooth brome (Fig. 3) which tends not to pile up or be smothered by results of late mowing unless grass is wet when mowed (Fig. 4).

Where bluegrass was the dominant species, yellow foxtail was sometimes abundant late in the season (Fig. 5). Since the foxtail is very succulent (contains much water), it tends to cause piling up when mowed short (4 inches) even if the grass surface is dry (Fig. 6).

Generally, it was found that mowing could be started much later than is generally done. Figures 7 and 8 show portions of I-74 in mid-June when grass is between 18 and 24 inches tall. The roads are not yet unsightly, sight distances are maintained at intersections and on the insides of curves, and guard, rails, signs, and other traffic control devices are still visible. This is especially true for roads where bluegrass is the dominant species. Figure 9 shows the Veedersburg test plot on July 31 along SR 28. This is very near the optimum timing. In 1973, when this picture was taken, 1-cycle mowing, the first week of August, would have been adequate.

A major objective of this study was to evaluate what, if any, harmful results would come from not mowing. In none of our tests did we note any harmful effects of not mowing on grass where weed control was adequate, e.g. along Interstates. In fact, no mowing was superior to 1- or 2-cycle mowing done poorly. The only serious drawback to not mowing is brush (Fig. 10). In the uniform test plots, unmowed test plots, unmowed plots contain willow, black locust, and other species, 1-3 feet tall by the end of the second year on non-maintenance. Other, plots, including those mowed only once or only once in 2 years, did not contain brush.



Fig. 3. Uniform mowing test plot along I-74 showing uniform stand of smooth brome which can be mowed virtually at any stage with good results if grass surface is dry at time of mowing.



Fig. 4. Piling up along Interstate I-65 due to grass being wet at the time of mowing. The practice of mowing wet grass should be forbidden.



Fig. 5. Uniform mowing test along SR 28 on September 10. Note heavy growth of yellowfoxtail in foreground.



Fig. 6. Close up of mowed portion of test area in Fig. 5. The heavy growth of yellowfoxtail led to considerable piling up and subsequent smothering of the blue grass.





Fig. 7. Portion of the I-74 photographed in the 3rd week of June, 1974. Grass is 18 to 24 inches high and at the proper stage for the first mowing.



Fig. 8. As in Fig. 7 except view from the side.





Fig. 9. Portion of SR 28 test plots photographed July 31, 1973. Except for growth of wild carrot (foreground), this plot required only a single midseason mowing.



Fig. 10. A major problem encountered in unmowed areas was the growth of brush. Brush develops into trees which are the most common form of roadside obstruction. Trees once established, are expensive to remove. Some form of brush control agent should be included in the spray mixture applied by off-road equipment on roads where portions are not mowed but where natural vegetation growth is not desirable, e.g. adjacent to tilled farmland.

Inspections of contract mowing.--Major findings from uniform test plots were verified from inspections of contract mowing. Generally, mowing could be delayed much longer than indicated from State mowing policy (p. 22) with no harmful effects. If anything, grass was being mowed too early and too short.

In general, the mowing program was good. I-65 received good maintenance, whereas I-74 was not as well maintained in some years, e.g. 1974. Most problems can be traced to weather, inadequate equipment, or contract difficulties. One serious problem arose when a contractor was awarded three contracts with only enough equipment to handle one.

Some specific problems noted with contract mowing of Interstates include:

1) Piling up (Figures 4, 6, 10 and 11). Piling up occurs usually when grass is either too heavy or too wet. Wetness is the greatest contributor. Fig. 11 shows a good mowing job except that mowing was done right after a heavy rain so that unnecessary piling up was the result (see also Fig. 4). Weedy grasses that contain much water, such as yellow foxtail, also contribute to piling up (Fig. 6). The piles tend to smother out the underlying turf and leave bare spots open to erosion and weeds (Fig. 10).

Piling up can be avoided by mowing only when the surface of the grass is dry.

2) Scalping. Scalping occurs when the mower blade cuts into the crown of the grass at the soil surface. Grass that has been scalped is either very slow to recover or killed. Scalping is largely a design problem, e.g. ridges in the right-of-way that are straddled by the mower, but is aggravated by cutting the grass too short. A maximum mowing height of 6 inches avoids much scalping, tends to reduce piling up, and produces a presentable roadside (Fig. 12).

3) Skips. Skips are the result of careless mowing. Strips left between mowing swaths are inexcusable and contractors who allow this practice should be penalized. Generally trimming around poles, signs, guard rails, etc. has been sporadic to poor. This is not a technical problem but rather a problem of enforcement. A practical solution is the use of growth retardant chemicals to prevent grass growth in



Fig. 11. An example of a good mowing job along I-74 except for scattered grass piles due to mowing when the grass was wet.



Fig. 12. Grass mowed to an average height of about 6 inches. Scalping and piling up are reduced. The appearance is adequate although not as "neat" as mowing to the now recommended height of 4 inches (Compare with Fig. 11).



these difficult-to-mow areas. Careful cost-benefit studies should be carried out with State Highway Officials to determine if use of growth retardants (not soil sterilants) around poles, signs, guard rails, etc. might actually result in substantial cost savings.

Evaluations of roadside areas where accurate mowing histories were available.

A considerable number of such areas were examined. Except for growth of brush in unmowed areas (Figs. 10 and 13), no deleterious effects of reduced maintenance were noted. The practice of mowing to the ditch or to the ditch plus 5 feet provides an attractive roadside (Fig. 13) and is a sound practice

- 1) As long as adequate sight distances are maintained and
- 2) Brush is controlled.

Brush control (either chemical or mechanical) must be considered as an integral part of the maintenance of unmowed rights-of-way.

A few test areas were encountered where unmowed roadsides had persisted for as long as 7 years without deleterious effects. These sites were located in a true prairie environment where brush invasion is somewhat less prevalent. Even here, however, introduced species such as black locust will become established. In other non-prairie sites, the woody vegetation is more natural to the environment and is a continual invader. One must either accept woody vegetation (brush and trees) in the unmowed areas or be prepared for a continuing fight.

Weed count data on areas that were both unmowed and unsprayed are limited. However, weed counts taken 2 years after spraying show consistent reduction of the "lawn type" annual weed species from unmowed roadsides (Table III). The eliminated species include dandelion, buckhorn plantain, and knotweed. Other species such as canada thistle, wild parsnip and milkweed are less affected, perhaps favored, in unmowed areas.

TABLE III

Weed populations comparing mowed and unmowed portions of interchanges in the Greenfield subdistrict 3 years after spraying with 2, 4-D amine. The unmowed portions were unmowed for about 5 years.

<u>Weed species</u>	<u>Plants/acre</u>	
	<u>Mowed</u>	<u>Unmowed</u>
Plantain	12,610	430
Dandelion	1,740	380
Clovers	3,450	1,225
Common thistle	1,300	1,400
Black medic	5,227	4,800
Common milkweed	650	780
Wild carrot	6,969	3,500
Knotweed	17,400	4,800
Composite family	2,600	2,750
Yellow woodsorrel	2,200	2,600
Other weeds	<u>6,000</u>	<u>5,450</u>
Total weeds	60,146	28,115



Legumes and need for early mowing.--A consistent observation in all of our studies is that roadsides seeded to legumes, especially red clover, appear unsightly early in the season and seem to require mowing not because of the grass but because of the legumes (Fig. 14). This is not as much due to a height differential but due to color and distribution of foliage. The legumes are only 1-3 inches taller than the grass in most instances. The legumes are a much darker green than the grass. The legumes have the greatest leaf density toward the top while the grasses have the greatest leaf density at the bottom. Visually, the legumes appear to be nearly twice as tall as the grass and to require mowing. Actual measurements show that this is not so. In any event, the roadsides appear unsightly.

The conflict between landscapers and weed controllers in the seeding of legumes is sometimes wasteful. The legumes may increase maintenance costs by perhaps as much as one mowing per season. As soon as the area is sprayed in the contract program, much of the legume population is killed. That which remains creates the kind of problem depicted in Fig. 14. Application of slow-release nitrogen fertilizer might prove less expensive than legume seeding if one mowing is saved when legumes are not present.

Information from other states. Based on observations of mowing practices in other states, the impression is that Indiana overmows. This is especially noticeable on roads under State maintenance. A most successful application of reduced mowing practices was encountered in central Europe when fuel is much more expensive than in the United States. Here nearly all roadsides received only a single mowing cycle late in the season (mid July to mid August). The effects are the continued maintenance of healthy turf, moderate regrowth before winter, control of brush species, a slightly "ragged" appearance in late June and early July, but a substantial cost saving relative to the Indiana program.



Fig. 13. Portion of I-74 south of Lafayette showing appearance of unmowed vs. mowed portion as winter approaches. Note evidence of brush encroachment in the unmowed portion.



Fig. 14. Portion of I-74 south of Indianapolis photographed June 5. Considerable growth of red clover causes the roadside to appear unsightly and to appear as if mowing were required whereas pure grass stands twice as tall would seem less unsightly (compare with Figs. 7 and 8).

CONCLUDING COMMENTS

Features to consider in determining highway mowing practices.--According to the New York State Department of Transportation Guide for the Determination of Mowing Limits, there are four categories of features which must be taken into consideration. These are highway safety, topography, adjacent land use and vegetation and existing vegetation within the right-of-way.

Highway safety.--According to the New York Guide "Highway safety overrides all other features affecting mowing practices. Sight distance at intersections and on the inside of curves must be maintained. Safety setbacks for major trees must be observed and guide rails, signs and other traffic control devices kept open to view." Obviously, maintenance of appropriate sight distances is the most important single reason that makes both mowing and weed control a required feature of roadside maintenance.

Topography.--Obviously the physical ability to machine mow will determine mowing limits. Ditches and other drainageways, e.g. those in medians, should be mowed to maintain water-carrying capacity. Slopes 1 or 2 or steeper are normally would not require mowing much beyond the ditch.

Adjacent land use and vegetation.--Whenever highway right-of-way borders on agricultural land of high productivity, mowing is justified to keep down weeds and brush, to prevent shading, and for good public relations. It is my experience that State roads bordering farms of high productivity are mowed regularly one way or another, if not by State crews than by the farmers themselves. One uniform mowing test was abandoned because the farmer whose soybean field bordered the test plots mowed the roadside despite personal pleas and the signs saying "DO NOT MOW."

Existing Vegetation within the right-of-way. It is often possible to mow around large masses of landscape plantings without mowing around individual plants. Pure stands of smooth brome or bluegrass may be easier to maintain than mixed stands. Certainly weeds and legumes (see Fig. 14) are a factor. When weeds are controlled, less mowing is required.

January 24, 1974

INDIANA STATE HIGHWAY COMMISSION

Mowing Policy

A. GENERAL

1. Where mowing is required, maintain height of vegetation between a 4" minimum and a 12" maximum.
2. Slopes steeper than 3:1 shall not be mowed.
3. Mow from the edge of the pavement, or the edge of the paved shoulder, to a point 5' beyond the ditch line in cut sections and 5' beyond the shoulder break in fill sections.
4. Mow any area that is necessary to provide satisfactory sight distance for the traveling public.

B. ROADSIDES

1. At locations where developed areas are adjacent to the right-of-way mow to the right-of-way line.

C. MEDIANS

1. The entire area of medians which are 60' or less in width shall be mowed.
2. The entire area of medians which are wider than 60' but which have only one center ditch shall be mowed.
3. Variable width medians with a ditch serving each pavement shall be mowed the same as Items 2 and 3 under A General.

D. INTERCHANGES

1. Additional mowing may be required in interchange areas to provide a satisfactory appearance. Such mowing shall be by methods and at intervals as directed by the Engineer.



RECOMMENDATIONS

1. WHERE MOWING IS REQUIRED: Safety and/or appearance a primary consideration.

Three (or two) cycle mowing with exact timing based on grass height. The desirable mowing height should be increased from 12 inches to between 18 and 24 inches with a minimum height for cut grass of 5 inches. Mowing of wet grass should be prohibited to reduce "piling up". Mowing should be in combination with the Fall-Spring Spraying Program for control of broad-leaf weeds.

2. WHERE MOWING IS NOT REQUIRED: Safety and/or appearance not a primary consideration.

Eliminate mowing entirely.

Fall-Spring Spraying Program for control of broad-leaf weeds must then be modified to include a brush control agent in the spray mixture.

OR

One cycle mowing in late July and early August ~~in~~ combination with the Fall-Spring Spraying Program for control of broad-leaf weeds.





COVER DESIGN BY ALDO GIORGINI