



Economic and Environmental Benefits of a Reduced Roadside Mowing Program for Kentucky Highways

Report Number: KTC-21-07/SPR20-590-1F

DOI: <https://doi.org/10.13023/ktc.rr.2021.07>



Kentucky Transportation Center
College of Engineering, University of Kentucky, Lexington, Kentucky

in cooperation with
Kentucky Transportation Cabinet
Commonwealth of Kentucky

The Kentucky Transportation Center is committed to a policy of providing equal opportunities for all persons in recruitment, appointment, promotion, payment, training, and other employment and education practices without regard for economic, or social status and will not discriminate on the basis of race, color, ethnic origin, national origin, creed, religion, political belief, sex, sexual orientation, marital status or age.

Kentucky Transportation Center
College of Engineering, University of Kentucky, Lexington, Kentucky

in cooperation with
Kentucky Transportation Cabinet
Commonwealth of Kentucky

© 2021 University of Kentucky, Kentucky Transportation Center
Information may not be used, reproduced, or republished without KTC's written consent.

Research Report
KTC-21-07/SPR20-590-1F

**Economic and Environmental Benefits of a Reduced Roadside Mowing Program for
Kentucky Highways**

Chris Van Dyke, Ph.D.
Research Scientist

Candice Wallace, Ph.D.
Research Scientist

and

Doug Kreis, Ph.D., P.E.
Associate Director

Kentucky Transportation Center
College of Engineering
University of Kentucky
Lexington, Kentucky

In Cooperation With
Kentucky Transportation Cabinet
Commonwealth of Kentucky

The contents of this report reflect the views of the authors, who are responsible for the facts and accuracy of the data presented herein. The contents do not necessarily reflect the official views or policies of the University of Kentucky, the Kentucky Transportation Center, the Kentucky Transportation Cabinet, the United States Department of Transportation, or the Federal Highway Administration. This report does not constitute a standard, specification, or regulation. The inclusion of manufacturer names or trade names is for identification purposes and should not be considered an endorsement.

June 2021

1. Report No. KTC-21-07/SPR20-590-1F	2. Government Accession No.	3. Recipient's Catalog No	
4. Title and Subtitle Economic and Environmental Benefits of a Reduced Roadside Mowing Program for Kentucky Highways		5. Report Date June 2021	
		6. Performing Organization Code	
7. Author(s): Chris Van Dyke, Candice Wallace, Doug Kreis		8. Performing Organization Report No. SPR-21-07/SPR20-590-1F	
9. Performing Organization Name and Address Kentucky Transportation Center College of Engineering University of Kentucky Lexington, KY 40506-0281		10. Work Unit No. (TR AIS)	
		11. Contract or Grant No. SPR 20-590	
12. Sponsoring Agency Name and Address Kentucky Transportation Cabinet State Office Building Frankfort, KY 40622		13. Type of Report and Period Covered	
		14. Sponsoring Agency Code	
15. Supplementary Notes Prepared in cooperation with the Kentucky Transportation Cabinet			
16. Abstract A growing number of state departments of transportation (DOTs) are introducing conservation mowing programs that aim to reduce the frequency of roadside mowing while expanding the footprint of pollinator habitat. Wanting to get a better handle on the utility conservation mowing, the Kentucky Transportation Cabinet (KYTC) funded this study to explore the economic and environmental benefits that accrue from mowing less often. This report presents a synthesis of best conservation mowing practices based on a review of landscape management policies, programs, and procedures in use at 15 state DOTs. Most agencies divide the roadside into discrete management zones. While they continue to mow regularly in the areas closest to roadways (extending roughly 15 feet or so from the edge of the shoulder), beyond this mowing is done less often and is combined with selective herbicide use to facilitate plant species favored by pollinators. Regardless of the mowing strategy adopted, vehicle safety must be preserved by maintaining adequate clear zones and sight distances. An economic analysis of different mowing strategies found that KYTC can save between \$9 million and \$24 million over a five-year period through mowing cutbacks. Eliminating a single litter cycle can generate an additional \$5 million in savings over the same period. To facilitate communication with the public, a proof-of-concept marketing document is put forward which explains to the driving public how KYTC is adjusting its landscape management practices. Dubbed <i>Kentucky's Buzzing!</i> , the goal is to provide the public with readily understood explanations of why pollinators matter and how the Cabinet can improve their fortunes through conservation mowing.			
17. Key Words pollinators, landscape management, conservation mowing, roadside asset management, herbicides		18. Distribution Statement Unlimited with approval of the Kentucky Transportation Cabinet	
19. Security Classification (report) Unclassified	20. Security Classification (this page) Unclassified	21. No. of Pages 57	19. Security Classification (report)

Table of Contents

Executive Summary	1
Chapter 1 Introduction	3
1.1 Introduction to Conservation Mowing	3
1.2 Report Structure	5
Chapter 2 Review of State Transportation Agency Mowing Practices	7
2.1 Tennessee	7
2.2 Ohio.....	8
2.3 Alabama	9
2.4 Florida	11
2.5 Pennsylvania	13
2.6 Indiana	15
2.7 Maryland.....	16
2.8 Missouri	18
2.9 Wisconsin.....	21
2.10 Nebraska	23
2.11 Texas	24
2.12 Virginia	25
2.13 Minnesota.....	29
2.14 Washington.....	30
2.15 Illinois.....	32
Chapter 3 A Synthesis of Trends in Mowing Practice at State Transportation Agencies.....	34
3.1 Where and When to Mow	34
3.2 Implementing Conservation Mowing	35
3.3 Communicating with the Public.....	36
3.4 Inventorying Green Assets.....	36
3.5 Interacting with Contractors and Maintenance Personnel.....	36
3.6 Plantings and Seed Mixes	37
Chapter 4 Analyzing and Projecting KYTC Mowing and Litter Removal Costs.....	38
4.1 Current and Projected Mowing Expenditures	38
4.2 Current and Projected Litter Removal Expenditures	40
4.3 Conclusions and Considerations	42
Chapter 5 KYTC’s Proposed 2020 Plan for Reduced Roadside Mowing	43
Chapter 6 KYTC’s 2021 Mowing Program.....	45
Chapter 7 Kentucky’s Buzzing! Marketing Campaign	48
Resources and References.....	50

List of Figures

Figure 2.1 INDOT Vegetation Management Zones	15
Figure 2.2 Missouri DOT Mowing Technique on Major Roads	20
Figure 2.3 WisDOT Interchange Mowing Locations.....	22
Figure 2.4 Virginia DOT Table of Mowing Dates (2010).....	27
Figure 2.5 Virginia DOT — Example Mowing Section	28
Figure 2.6 Washington DOT Map of Pollinator Habitat Rankings.....	32
Figure 2.7 Illinois DOT SAVE Mowing Annual Progression	33
Figure 3.1 Idealized Vegetation Management Zones	34
Figure 5.1 Proposed 2020 Mowing Strategies.....	44
Figure 6.1 KYTC 2021 Mowing Plan	46
Figure 7.1 Marketing One-Pager for Kentucky's Buzzing!	49

List of Tables

Table 1.1 Mowing Types Used By KYTC	3
Table 1.2 Consequences of Road Development	4
Table 1.3 Timeline for Native Plant Establishment.....	5
Table 2.1 Alabama DOT Mowing Techniques.....	10
Table 2.2 PennDOT Mowing Operations	13
Table 2.3 Maryland SHA Priority Area Mowing Practices (c. 2003).....	17
Table 2.4 Missouri DOT 2003 Mowing Guidelines.....	19
Table 2.5 Wisconsin DOT Rural Area Clear Zone Widths.....	21
Table 2.6 Nebraska DOT Mowing Practices by Highway Type.....	23
Table 2.7 Texas DOT Mowing Practices.....	25
Table 2.8 Virginia DOT Mowing Practices.....	26
Table 2.9 Washington DOT Maintenance Practices by Roadside Zone	30
Table 4.1 2019 Contracted Mowing Expenses.....	38
Table 4.2 2020 Contracted Mowing Expenses.....	39
Table 4.3 Anticipated 2020 Mowing Expenses (One Type 2 Cycle)	39
Table 4.4 Projected Mowing Expenses (Elimination of One Type 3 Cycle).....	40
Table 4.5 Mowing Costs and Cumulative Savings for Different Mowing Scenarios (2020-2025).....	40
Table 4.6 2019 and 2020 Litter Removal Expenditures	41
Table 4.7 Litter Removal Costs and Cumulative Savings for a One-Cycle Reduction (2020-2025).....	41
Table 6.1 Key Features of KYTC's 2021 Mowing Plan	45

Executive Summary

Roadside mowing is a significant maintenance expense for the Kentucky Transportation Cabinet (KYTC). In 2019 the agency spent nearly \$12 million on contract mowing. Seeing that a growing number of transportation agencies have introduced conservation mowing programs that have resulted in considerable savings while at the same time expanding the availability of pollinator habitat, the Cabinet asked our Kentucky Transportation Center (KTC) team to investigate the economic and environmental benefits of reduced mowing frequencies on roadside landscapes and to outline what conservation mowing might look like if implemented throughout the state.

To answer what a conservation mowing program at KYTC could look like, we reviewed the mowing and landscape management practices used at 15 state departments of transportation (DOTs). Our analyses were built from evaluations of policy and guidance manuals, agency websites, and interviews with agency stakeholders — typically staff working in maintenance or environmental divisions. Based on this investigation, we compiled a synthesis of best practices. The synthesis describes where and when mowing should be done and briefly touches on questions related to herbicide applications, vehicle safety, program implementation, advertising new practices to the public, dealing with contractors and maintenance personnel, and seed mix design.

Figure E1 illustrates roadside management zones using an idealized roadway cross section. Zone A is the roadway (including paved shoulders and gravel shoulders) and should be kept entirely free of vegetation, usually through the use of non-selective herbicide treatments. In Zone B — the median — when the total median width exceeds a specified threshold (e.g., 70 feet), 15-foot strips are routinely mowed adjacent to the roadway for vehicle safety and interior areas are mowed just once per year to facilitate the growth of pollinator-friendly species. Selective herbicides may be applied as needed to suppress undesirable species. Zone C is the clear zone along exterior shoulders. This area is also mowed routinely. Zone C's width can vary, ranging from 10 feet to 35 feet based on road type. Finally, Zone D extends beyond the clear zone and is set aside for natural management. Management practices used in this zone include spot mowing, selective herbicides treatments, and trimming of woody vegetation — some agencies undertake a complete mow out once per year, or at 2-3-year intervals. The management goal in Zone D is to preserve as natural a landscape as possible while driving out undesirable non-native species.

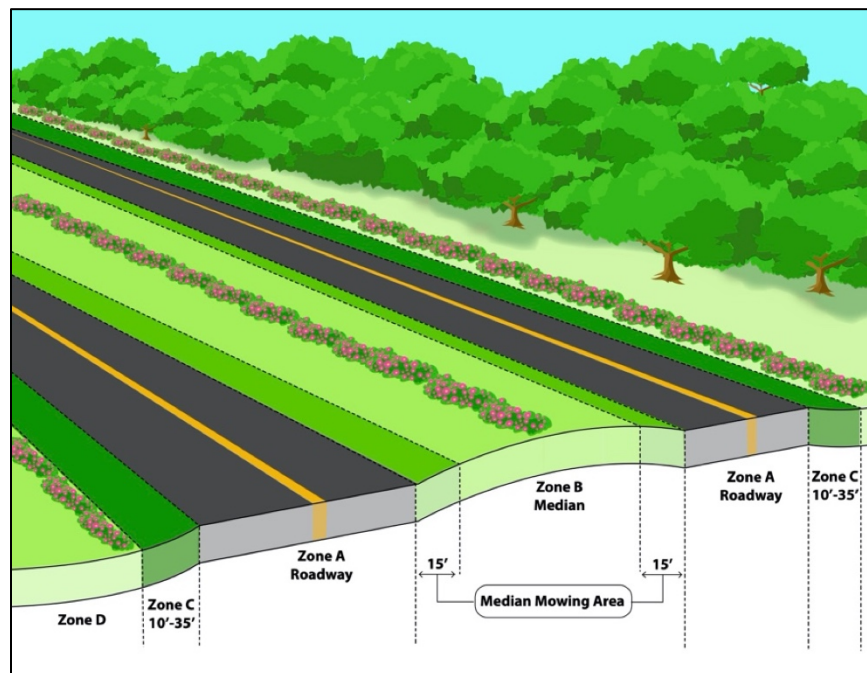


Figure E1 Idealized Roadway Cross Section

To gauge potential savings that could be realized through a conservation mowing program, we estimated expenses under different scenarios. Specifically, we estimated savings associated with (1) eliminating one Type 3 mowing cycle and (2) converting one Type 3 cycle to a Type 2 cycle.¹ Here, the Type 2 cycle functions as a sort of proxy for standard conservation mowing given that it entails mowing a 10-foot strip adjacent to the roadway. Over five years, converting a Type 3 cycle to a Type 2 cycle statewide could yield roughly \$9.5 million in savings, whereas cutting out a Type 3 cycle would produce nearly \$24 million in savings. We also looked at litter cycles. The number of litter cycles varies throughout the state. So, we adopted a conservative approach of estimating how much could be saved by cutting out one cycle. Over five years, it is possible that KYTC could accrue over \$5.1 million in savings. While the estimates developed are imperfect and cannot precisely model how much mowing would be done under a fully implemented conservation mowing program, they offer a baseline.

In October 2019 Central Office Division of Maintenance staff circulated a plan for reduced roadside mowing. Our team compared the proposed plan to the best practices synthesis described above. Although they are largely congruent, KYTC may want to consider strategy modifications in a few areas — 1) cut out routine mowing of median interiors if medians exceed a threshold width; 2) explore whether it is sensible to perform complete mow-outs of rights of way less often; and 3) use selective herbicide treatments in areas that are mowed less often to quell the emergence of undesirable plant species. The Cabinet subsequently introduced mowing strategies for 2021 that focus on improving pollinator habitat along rural interstates, parkways, other selected routes.

While development of a full marketing campaign for conservation mowing was beyond the scope of this project, we assembled a one-page document which explains the benefits of pollinators and describes why roadsides will be mowed less frequently. The marketing initiative is dubbed *Kentucky's Buzzing!* Consistent with best practices, it is imperative to communicate with public about changing management practices and their impacts on landscape aesthetics and user safety.

¹ Type 2 mowing entails mowing a 10-foot strip adjacent to roadsides, while Type 3 mowing involves mowing the entire roadside area out to designated boundaries.

Chapter 1 Introduction

Over the past 15 years or so a growing number of state departments of transportation (DOTs) have shifted toward conservation mowing to manage roadside landscapes. Conservation mowing blends less frequent mowing outside of the clear zone and a dedicated effort to cultivate more pollinator-friendly habitats. Key animal pollinators in North America include bees, butterflies, moths, wasps, beetles, ants, bats, and several bird species (e.g., hummingbirds). It is easy to see why agencies have embraced conservation mowing. Mowing reduces expenses, while also conferring significant environmental benefits. Roadside habitats can function as linear corridors which help connect remnant habitat patches and can therefore provide refuge for vulnerable species such as honeybees and Monarch butterflies, which have both endured significant losses in population over the past 50 years (FHWA 2015a).

The Kentucky Transportation Cabinet (KYTC) is interested in adopting conservation mowing strategies with the goal of spending less on mowing while creating roadside landscapes that support pollinators. In 2019 KYTC spent nearly \$12 million on contract mowing (see Table 4.1), a figure which has been steadily increasing over time. The Cabinet's *Maintenance Guidance Manual* lists two types of mowing performed by the agency and its contractors — Type 2 and Type 3 (Table 1.1). Type 2 mowing concentrates on narrow strips adjacent to the roadside while Type 3 is a full mow out of the roadside area. Vegetation up to one inch in diameter is also mowed during normal mowing operations. As will be seen, Type 2 mowing has affinities with conservation mowing practices. Many agencies routinely mow 15-foot strips next to the shoulder to preserve an adequate clear zone, but trim vegetation outside this area less frequently to encourage growth of pollinator-friendly vegetation. In response to the COVID-19 pandemic and attendant budget concerns, in 2020 KYTC converted its first mowing cycle to a Type 2 cycle. Even so, the Cabinet remains hopeful it can devise a long-term mowing and landscape management strategy that entails sustained mowing reductions. To explore potential strategies, the agency retained our Kentucky Transportation Center (KTC) research team to look at how other DOTs approach conservation mowing and identify best practices suitable for the state. Before jumping into the heart of the report, we briefly introduce some recent work done on conservation mowing management strategies designed to facilitate pollinator habitat. This review is not exhaustive as our primary focus was on what is going on at other transportation agencies.

Table 1.1 Mowing Types Used By KYTC

Mowing Technique	Description
Type 2	<ul style="list-style-type: none">• A 10-foot strip is mowed along the outside shoulder or pavement edge along roadways and interchange ramps, including all normal width medians.• Where the roadway separates beyond the normal median width, along the inside shoulder 10-foot strip is mowed inside the paved shoulder or pavement edge, including all areas that can be mowed inside interchange ramps.
Type 3	<ul style="list-style-type: none">• The entire roadside area is mowed. This includes all areas that can be mowed out to the rights-of-way fence, mowing stake line, or other designated mowing limit

1.1 Introduction to Conservation Mowing

The basic ideas underpinning conservation mowing are quite simple — reduce mowing frequency to minimize damage to vegetation, time mowing to avoid disrupting critical stages in pollinator life cycles and encourage the growth of native vegetation, and implement techniques (e.g., adjusting mower blades) to keep vegetation at an optimal height. Any conservation mowing program should be coupled with targeted herbicide applications to prevent weeds and undesirable vegetation from outcompeting native plants favored by pollinators. DOTs are coming to view roadsides as ideal settings for expanding the foothold of habitat pollinators are most attracted to. While roadside spaces can provide habitat, it is important to recognize that roads create issues which complicate efforts to create new pollinator-habitat. But thoughtful management strategies can mitigate negative impacts. Table 1.2 lists the positive and negative effects of roads on pollinators (Wojcik and Buchmann 2012).

Table 1.2 Consequences of Road Development

Positive Effects	Negative Effects
<ul style="list-style-type: none"> Water runoff creates hedgerow effect of new growth 	<ul style="list-style-type: none"> Direct elimination of habitat area (new road construction)
<ul style="list-style-type: none"> Increased flowering promotes bees, other pollinators, grazing by herbivores 	<ul style="list-style-type: none"> Bisect and fragment landscapes into habitat islands (new road construction)
<ul style="list-style-type: none"> Thoughtful management fosters or resets succession promoting colonizing species 	<ul style="list-style-type: none"> Conduits for dispersal of weeds and exotic animals
<ul style="list-style-type: none"> Creates new bare ground along edges, promoting bee nesting 	<ul style="list-style-type: none"> May alter migratory patterns, especially for larger animals
<ul style="list-style-type: none"> Road-killed individuals provide important food for avian raptors, other birds, mammals, and certain invertebrates 	<ul style="list-style-type: none"> Allows deep access into wildlands for further exploitation
	<ul style="list-style-type: none"> Increases wildfire frequency (e.g., discarded cigarettes)
	<ul style="list-style-type: none"> Introduction and spread of gasoline, exhaust fumes, rubber particles from tires
	<ul style="list-style-type: none"> Mortality due to interactions with vehicles and traffic (e.g., roadkill)

Despite challenges associated with road construction and maintenance, academic and technical research has confirmed that roadside landscapes can facilitate pollinators if managed properly. Gardiner et al.'s (2018) synthesis looking at previous work on the conservation potential of rights of way found that maintaining habitat in an early or immediate successional stage via mowing and woody plant removal and warding off undesirable species fosters diverse plant communities that accommodate rare and threatened invertebrates (see also Wojcik and Buchmann 2012). Mowing too early in the season can inhibit the reproductive success of plants, while mowing later in the growing season and reducing the frequency or extent of vegetation management increases the abundances of flower-visiting insects like butterflies. Noordijk et al. (2009) documented the highest flower diversity in areas mowed twice per year with removal of cuttings and showed that high plant diversity promotes high flower abundance. Jakobsson et al. (2018) arrived at similar conclusions, finding that higher plant species richness on roadsides mowed twice per year than in locations mowed at different intervals, and that removing cuttings bolsters species numbers (cf. Jantunen et al. 2007). Valtonen et al. (2006) recorded higher butterfly and moth abundances in areas that were partially mown compared to those which were fully mown. While cautioning that life cycles vary among species, they suggested that mowing in the late summer will prove beneficial to most invertebrates and that leveraging a mosaic approach to mowing can potentially increase species richness. Hopwood (2008) verified that seeding roadsides with native vegetation bolsters plant diversity, which in turn improves the abundance of pollen and nectar sources. In addition to observing higher bee richness on restored roadsides, Hopwood also established that native grasses are effective at mitigating erosion and controlling weeds (see also Entsminger et al. 2019).

Numerous technical documents have been released which summarize best management practices for managing and restoring roadside habitats for pollinators (e.g., FHWA 2015, Hopwood et al. 2015, FHWA 2016, Galea et al. 2016, Natural Resources Conservation Service [NRCS] 2016, Cariveau et al. 2020). Galea et al. (2016) catalogued methods for enhancing pollinator habitat. These include targeted mowing, treating no more than one-third of any roadside with herbicides at once as this helps maintain adequate food sources for pollinators, strengthening pollinator habitat connectivity, and scheduling mowing to minimize impacts to pollinators (ideally, mowing no more than twice per year). They also included a checklist that can be used to evaluate whether sites are appropriate for pollinator habitat (see p. 24). The NRCS (2016) recommends adopting a patch-based approach to mowing and not disturbing more than 25% to 35% of pollinator habitat by mowing, grazing, or haying at one time, developing management practices which are sensitive to pollinator life cycles, preserving bare patches to aid ground-nesting pollinators, avoiding the use of broad-spectrum chemicals if possible, focusing on the use of native plantings, and working to control interspecies competition in the first three years following the installation of pollinator habitat. Hopwood et al. (2016) laid out steps maintenance personnel and roadside managers can take to expanding pollinator habitat. Two key

steps are (1) increasing the abundance of pollen, nectar, and host-plant resources by planting and supporting a diverse range of plants which flower throughout the year, and (2) creating a vegetation structure that offers ample space for pollinators to nest, lay eggs, and overwinter — ideally within the same habitat patches. They warned against mowing during the growing season in places where vegetation is home to rare, sensitive, and endangered pollinator species. Mowing too often can also reduce native plant growth and leaves forbs competitively disadvantaged against grasses. In line with other work, they recommended mowing once per year as well as specific mowing techniques: using the flushing bar on mowers, cutting back mower speeds, and mowing to a height which benefits pollinators. Hopwood et al. also provided a timeline for establishing native plants that is useful for setting realistic expectations with respect to aesthetics and maintenance. (Table 1.3). It is important to recognize that altering management strategies does not transform a roadside landscape overnight — it is a multi-year process.

Table 1.3 Timeline for Native Plant Establishment

Year	Appearance	Required Maintenance
1	<ul style="list-style-type: none"> Roadside has a messy appearance Annual or biennial weeds may be present 	<ul style="list-style-type: none"> Mow vegetation as needed to a height to 10" or more to suppress weeds and foster native plant growth
2	<ul style="list-style-type: none"> Growth of many grasses Emergence of a few quick-establishing wildflower species 	<ul style="list-style-type: none"> Mow once or as needed to suppress weeds and reduce competition for native plants
3	<ul style="list-style-type: none"> Roadside begins to look like a meadow 	<ul style="list-style-type: none"> Spot mowing or herbicides as needed for weed control
4	<ul style="list-style-type: none"> Roadside has a meadow aesthetic 	<ul style="list-style-type: none"> Vegetation is mostly self-sustaining Minimal maintenance to reduce woody plants and invasive weeds

* After Hopwood et al. (2016)

The National Cooperative Highway Research Program (NCHRP) has funded several projects related to pollinator conservation and vegetation management. Most recently, Cariveau et al. (2020) delivered a set of tools DOTs can use to expand the footprint of Monarch Butterfly habitat. These include a landscape prioritization model, a protocol for quickly survey roadsides to discern habitat quality for Monarchs, a roadside Monarch habitat calculator for determining whether conservation actions are needed and informing adaptive management, and a suite of decision-support tools for road managers to match up agency regulations and objectives with conservation goals. Although their work is narrowly focused on Monarch butterflies, they also discussed best practices for mowing and herbicide applications which are applicable beyond Monarchs. For example, agencies will benefit from using an Integrated Roadside Vegetation Management (IRVM) plan to suppress weeds and undesirable vegetation, limiting the use of nonselective herbicides, insisting on efficient herbicide use, minimizing the likelihood of herbicides drifting offsite, and restricting direct exposure to herbicides. An ongoing NCHRP project (25-29) will culminate in a guidebook that transportation agencies can use to design and implement programs geared toward improving pollinator habitat (the project will continue until 2022).

As noted, the purpose of this brief introduction is not to exhaustively document every facet of conservation mowing. Readers wanting to immerse themselves in the high-level principles of roadside landscape maintenance and restoration (as opposed to agency-specific approaches) will benefit from consulting the materials cited in this section. Before we jump into to our investigation of agency practices, we offer a brief outline of the report below.

1.2 Report Structure

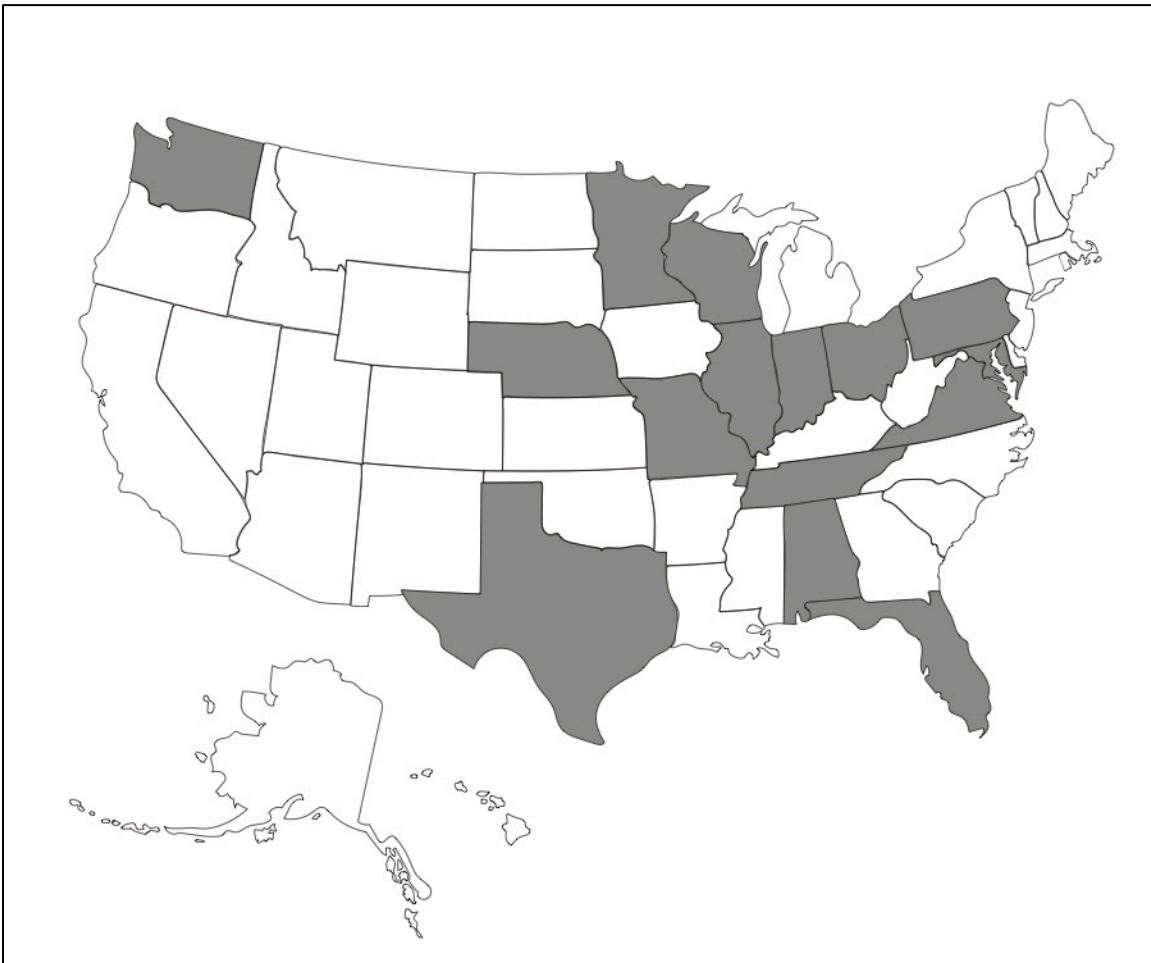
The rest of this document is divided into five chapters, each of which is briefly summarized below.

- Chapter 2 discusses mowing and landscape management practices that are currently used by 15 DOTs throughout the United States. Narratives draw from guidance manuals, policies, and interviews with agency stakeholders. In addition to mowing practices, we discuss pollinator habitat initiatives.

- Chapter 3 presents a synthesis of best conservation mowing practices based on the information gathered from DOTs. Topics addressed in this chapter include the zonation of roadside landscapes, mowing frequencies, the impact of mowing reductions on herbicide use, implementation strategies, methods for communicating with the public about conservation mowing and pollinator benefits, and plantings.
- Chapter 4 offers an economic analysis that attempts to forecast the amount of savings KYTC could reasonably expect to see under different mowing and litter removal scenarios.
- Chapter 5 examines a proposed 2020 mowing plan that was circulated in October 2019, KYTC's Central Office and among Roadside Environmental District Administrators (REDAs). Although the plan is generally consistent with other conservation mowing plans, we identify a few points of divergence which merit attention going forward. The final portion of Chapter 5 presents the mowing plan adopted in 2021.
- Chapter 6 includes a one-page document the Cabinet could distribute as part of a marketing campaign to explain why conservation mowing is beneficial and the importance of pollinators for human livelihoods. The campaign is dubbed *Kentucky's Buzzing!* and is focused on reassuring drivers and the public that mowing less will help to transform roadside landscapes while not compromising vehicle safety.

Chapter 2 Review of State Transportation Agency Mowing Practices

This chapter summarizes the mowing practices at state transportation agencies around the country, with a focus on the Southeast and Midwest as well as agencies which have introduced programs designed to reduce how often they mow roadsides. Although it does not capture how mowing is tackled by every agency throughout the US, it offers a representative sample which is sufficiently comprehensive to understand key trends. To achieve as much consistency as possible in the write-ups presented below, in most cases a standard narrative structure is followed. Each narrative begins with an introduction to the agency being discussed and provides a high-level overview of its approach to mowing and vegetation management. Following this introduction, more detailed information is provided on mowing practices (e.g., mowing frequencies and which areas are mowed). Discussions turn lastly to pollinator initiatives and the public's receptiveness to changes in mowing practices. Some narratives deviate slightly from this structure. In some cases, agencies have funded research to assess the effectiveness of their practices or refine mowing policies. Details of these studies are presented where they are germane. Although these narratives attempt to be as uniform as possible in what information they present, in some cases agency staff did not know or lacked access to particulars (e.g., number of acres managed or exact number of mowing expenses). To assemble these narratives, we drew from many sources: websites, guidance, policy manuals, press releases, reports, and interviews with agency stakeholders. The map below indicates which state policies are discussed.



Focal State Transportation Agencies

2.1 Tennessee

The Tennessee Department of Transportation (TDOT) manages vegetation on approximately 80,000 acres. During the 2013 mowing season the agency launched a swath mowing program on the interstate corridors it manages. The

program's rollout was gradual, with new areas added over the subsequent five years. To date, swath mowing has been implemented on 13,000 acres. It was introduced as a response to falling state revenues, and its primary goal was to reduce vegetation management costs without compromising level of service. Swath mowing has not been extended to state routes or interstates located in urban areas. Vegetation management practices along these corridors remain unchanged. State routes are fully mowed 3-4 times per year. Integrated vegetation management guidelines issued by the agency specify that mowing is to be done to a uniform height no less than 4-6 inches.

On corridors where the program has been adopted, TDOT performs four swath mowing cycles each year and one full mowing. Agency representatives noted that it is important to conduct a least one full mowing per year to protect equipment and maintain vegetation in a state of early succession. During a swath mowing cycle, crews mechanically mow a 15-foot-wide strip of vegetation parallel to the outside shoulder. Medians 60 feet or less in width are mowed in their entirety. However, if median width is greater than 60 feet, crews mow a strip 15 feet wide extending inward from the edge of the paved surface. Vegetation is not mowed beyond this point during swath mowing. If crews identify vegetation that is obstructing signage or other infrastructure (e.g., cable barriers) in areas where swath mowing is used, hand trimming is done to ensure it remains visible. If a median barrier wall is present, the entire ROW is mowed. No data have been collected indicating that swath mowing results in more deer-vehicle interactions.

TDOT contracts out about 80 percent of its mowing. Contracts specify the width of areas that are to be mowed. No staking is used. In recent years, due to the rising price of contract mowing the agency has brought some additional mowing back in-house. Contractors, having grown accustomed to a certain level of revenue, have expressed some resistance to swath mowing. However, resistance has been less problematic where greater competition is present (i.e., multiple contractors available to bid on mowing contracts). Unit prices for swath mowing and full mowing are equivalent. Nonetheless, TDOT representatives also noted that it is important to closely monitor the price of litter removal as some contractors may attempt to boost prices on litter removal to offset losses incurred by mowing fewer acres (the cost of litter removal, staff commented, has grown excessive). Swath mowing has not generated the level of savings originally expected. Areas which now fall under the swath mowing program previously underwent four full mowing cycles; now they undergo a total of five mowing cycles. Because contractors have to keep on personnel longer to cover the fifth mowing cycle, agency personnel speculated this may potentially affect costs. While the decision to introduce swath mowing was originally justified on economic grounds, TDOT now views it as a valuable strategy to enhance pollinator habitat.

TDOT has not made a concerted effort to publicize swath mowing and has received few complaints from motorists and property owners. The agency's Pollinator Habitat Program webpage mentions swath mowing as being a part of efforts to conserve pollinator habitat, but no additional press releases or informational materials have been distributed. Motorists have grown accustomed to swath mowing, although TDOT has heard some drivers express confusion about the change in vegetation management practices when they travel rural into urban areas (or vice versa). These are the transition zones in which swath mowing begins or ends. If a motorist submits a question to TDOT about swath mowing the agency responds by explaining what the practice is and why it has been adopted. Agency personnel recommended that public outreach would be beneficial if a state transportation agency plans to introduce a reduced mowing program throughout an entire transportation network at once (e.g., a single mowing season).

While swath mowing has not been publicized, TDOT is promoting efforts to improve pollinator habitat. The agency has developed interpretive signage to place at new habitat installations. Signs have been installed at one Welcome Center to date, and the agency is working to plant pollinator habitat at an additional Welcome Center. Eight plantings are currently in the works at state parks as well. Thus far, the agency has planted 37 acres of pollinator habitat. Over the next two years staff hope to plant 50-60 more acres. Pollinator guidance is currently being prepared by TDOT; once completed it will be incorporated into the agency's *Landscape Design Guidelines*.

2.2 Ohio

The Ohio DOT (ODOT) introduced its conservation mowing program in May 2018. Key goals of the program include reducing maintenance expenditures, increasing pollinator habitat, and meeting its conservation obligations under the Candidate Conservation Agreement with Assurances (CCAA). Currently the agency owns and manages 260,000

acres of ROW. Approximately 80,000 of these acres fall under the conservation mowing program's purview. Before shifting to a reduced mowing regiment, most agency-owned acreage was mowed 4-5 times per year; in urban settings, some locations are trimmed up to six times each year to ensure motorist safety. In areas where conservation mowing has gone into effect, ODOT mows once per year and performs targeted mowing or herbicide treatments as necessary. From the program's introduction in May 2018 through October 2019, the agency reported saving \$2.2 million. Agency officials estimate the program will yield \$2 million in annual savings (compared to CY 2017 mowing costs). Most of ODOT's mowing is done by in-house crews. In 2019, the agency's in-house mowing costs were \$8.1 million; contract mowing costs amounted to \$1.8 million. No contractors have pushed back against the new mowing program.

To fulfill its CCAA commitments, ODOT formalized conservation mowing guidelines in June 2019. These guidelines, developed in partnership with Pheasants Forever, specify that the maximum allowable ROW that can be mowed is 30 feet from the edge of the pavement, with the following areas being exempt: medians, clear zones, urban areas, and ROWs that extend less than 30 feet from the pavement edge. The agency mows backslopes once per year. When mowing is performed on backslopes is dictated by location. North of Interstate 70 — a highway which bisects the state — mowing occurs between October 1 and May 1; there is also a brief summer window for mowing between June 30 and July 10. South of Interstate 70 mowing takes place between October 15 and April 1, with a mid-summer mowing window that runs from July 1 to July 20. Vegetation is mowed to a height of 8 to 10 inches. Where noxious or invasive species have been identified, mowing should not occur in the fall. Rather, these areas are mowed in the spring. Follow-up mowing or herbicide treatments are used to stymie the development of new seed heads. If a site lacks noxious or invasive weeds, mowing is completed in the fall — as vegetation is dormant in the late fall and winter months, the guidelines assume no spring mowing will be necessary. In some cases, signs or physical infrastructure zones where reduced mowing occurs require supplemental trimming to preserve their visibility. When crews identify these locations, they will clear out vegetation. Maintenance crews try to avoid mowing when pollinators are less active (early morning, dusk, night) as adult pollinators are less likely to escape mowers during these periods. The agency collaborated with the Ohio State University's extension program to develop a recommendation sheet for herbicides. ODOT prefers the use of selective herbicides, which target specific weeds, rather than broad-spectrum chemicals, as the latter can remove floral resources and potentially harm pollinators. ODOT implemented its new mowing guidelines in 2018 on secondary two-lane routes; in 2019 adoption expanded to priority four-lane routes. During the first two or three years following adoption of conservation mowing, agency personnel expect more intensive weed control will be necessary, with problems declining thereafter.

ODOT is moving aggressively to expand pollinator habitat on agency-owned lands. So far, the agency has established 1,200 acres of high-quality pollinator habitat and has plans to develop 125 new acres of high-quality habitat each year to fulfill its CCAA obligations. By 2022, it would like to have at least one pollinator habitat project in each county. Areas in which pollinator habitat has been developed include roadsides, highway interchanges, rest areas, shuttered rest areas and weigh stations, at agency garages, and brownfields. One strategy ODOT has leveraged to increase pollinator resources is using diverse seed mixes with native grasses and wildflowers, instead of relying on cool-season grass plantings. Agency staff have said it is important to ensure all personnel understand why ODOT has shifted to a reduced mowing schedule in many areas, as well as the benefits of the pollinator program, so they can communicate this information to the public. Other strategies the agency has adopted to educate motorists about mowing and pollinator initiatives include developing fact sheets and handouts with frequently asked questions which address potential concerns about aesthetics, conducting outreach on social media, installing signage that designates pollinator habitat zones, issuing public service announcements, and offering promotional items (license plates, seed packet handouts, wildflower handbooks). ODOT also works with some municipalities and has entered into public-private partnerships (P3s) to establish pollinator plots. Developing these plots costs up to \$400 per acre.

2.3 Alabama

The Alabama DOT (ALDOT) released its current guidance on roadside vegetation management in 2018. Although some materials were revised for this publication — and information on herbicide usage is updated regularly — most of the policies found in the guidance represent a continuation of practices the agency had previously adopted. The agency is responsible for managing vegetation along roughly 10,000 to 11,000 lane miles and has annual mowing budget of \$12 million. Approximately 50% of ALDOT's mowing is contracted out. Contractors handle mowing on

most of the state’s interstate systems, however, each of the agency’s districts has the autonomy to decide whether to use in-house or contract forces to mow. While some contracts combine mowing and litter removal, this is not universally the case. Since the 1980s, the agency has promoted the growth of wildflowers on its ROWs. In addition to encouraging the growth of wildflowers, the agency’s policy is to preserve naturalized wildflowers occurring on the land it manages. This includes directing maintenance forces to mow around wildflowers and avoid spraying them with herbicides.

ALDOT requires the preservation of adequate sight distances at horizontal and vertical curves, intersections, railroad crossings, signs, signals, delineators, hazard markers, and warning devices. Necessary sight distances are maintained on horizontal curves by mowing 30 feet from the edge of the traveled way outward. All vegetation must be kept in a condition that permits clear visibility of all traffic signs. In general, mowing height is kept at 6 inches, although this may vary (e.g., in wildflower areas). Another goal of the mowing policy is to blend landscaping on state-owned ROWs into adjacent land uses. ALDOT leverages three types of mowing – full-width mowing, strip mowing, and spot mowing. Practices are described in Table 2.1. Strip mowing has been adopted on approximately 10% of the agency’s lands; the main justification for using strip mowing is to reduce the number of mowing cycles and boost economic savings. At rest areas, welcome centers, and other areas where the landscape has been enhanced, mowing is done more often to maintain pleasing aesthetics. More frequent mowing may also be done in new construction areas to suppress competition from grass and other noxious plants. Mowing and targeted herbicide applications are coordinated to control the spread of undesirable plants. Two other mowing-specific guidelines merit attention. Along with identifying areas that should not be mowed, districts are required to calculate (in acres) the quantities of full-width mowing and strip mowing to be done on each roadway section. These calculations are used to develop contract bid proposals and assess equipment and personnel time as well as other factors that affect maintenance costs. Second, mowing procedures vary across Alabama due to differences in type of vegetation, ROW, location, and available equipment. District Administrators are responsible for establishing mowing procedures in their respective districts.

Table 2.1 Alabama DOT Mowing Techniques

Mowing Operation	Description
Full-Width Mowing	<ul style="list-style-type: none"> • Encompasses all unpaved ROW • Exempts designated non-mow areas and locations identified by District Administrators
Strip Mowing	<ul style="list-style-type: none"> • Areas from the edge of the travel lane or paved shoulder to the roadway ditch are mowed, plus one mower width up the backslope • Includes mowing required to maintain adequate sight distances for a variety of features, mowing the entire ROW in developed areas and in areas where full mowing is required for drainage, and mowing around all physical features (e.g., signs, guardrail) in the designated strip
Spot Mowing	<ul style="list-style-type: none"> • Mowing individual areas within the ROW to improve aesthetics, functionality, or safety • Typically performed when safety needs emerge between scheduled strip mowing cycles

Beginning in the mid-1980s, ALDOT sought to increase the use of wildflowers in its landscaping practices. Since 1987 the agency has planted over 1,000 acres of wildflowers throughout the state. To foster vibrant wildflower plots and the growth of native endangered plant species, ALDOT privileges the development and implementation of local maintenance plans. Planting strategies aim to establish and sustain an attractive plant community consistent with local growing requirements; ideally plants should flower at different periods throughout the year (i.e., sequential bloom) and be capable of reseeding a site for future generations of new plants. The agency’s vegetation management manual provides instructions on how to identify which sites are best suited to stands of wildflowers

based on their characteristics (e.g., lighting requirements, topography, soil characteristics). Protocols for site assessments are provided as well. During these assessments the agency recommends inventorying plants, identifying weeds, and documenting past land uses. Locating weeds on proposed sites and in the surrounding area, as well as looking at anticipated successional trajectories, is critical for not planting in areas where perennial weeds flourish and are hard to control. Three types of planting strategies are used by ALDOT: 1) new plantings, 2) existing wildflower areas, and 3) endangered species areas. The first refers to new installations, which should be visible to motorists for long periods of time while driving and incorporate colorful annuals. The second planting strategy is focused on where wildflowers occur naturally; in these areas, maintenance is generally sporadic, however, woody vegetation should be controlled. With endangered species areas, the appropriate planning and reporting to preserve critical species is undertaken.

ALDOT has developed mowing guidelines that apply to areas in which wildflowers are planted. Most of these plots are maintained with an annual mowing to prevent successional development from moving on to the herbaceous plant stage. However, in sites that lack shrub growth, mowing may be done at intervals ranging from one to three years. If a site contains significant brush, it should be mowed each year. Mowing activities are timed to meet three objectives – 1) removing weeds before they flower and produce a viable seed head, 2) facilitating dispersal of mature wildflower seed (as this can help reseed a site), and 3) removing dead plant material and enhancing aesthetics. Each fall, once flowers have completed their bloom and have set to seed wildflower areas are mowed to a height of 4-6 inches. Targeted use of herbicides is also done to suppress weed activity.

2.4 Florida

Most profiles in this section jump straight into a discussion of current state policies. However, this narrative about the Florida DOT (FDOT) begins by reviewing a study (Harrison 2014) the agency commissioned to assess what benefits sustainable roadside vegetation management could bring in terms of ecosystem services and economic savings. The thrust of Harrison's study is that roadside vegetation should be viewed as an asset by FDOT, as well as other agencies, due to the ecosystem services it confers. Across the United States, he found that approximately 64% of transportation agency ROWs consist of turf grass, with the remainder made up of shrubs, trees, and tree/grass communities. This figure established a baseline assumption for his estimates. FDOT owns nearly 190,000 acres of ROW along its state highway system (SHS), with approximately half being vegetated. Harrison found wildflower areas made up less than 1% of the total vegetated ROW on the SHS. He determined that maintaining vegetation on the state-owned ROWs cost roughly \$414 acre; this figure was based on seven mowing cycles per year. However, the amount of mowing done throughout Florida varies greatly, with frequencies increasing from north to south. Cost savings estimates assumed a 50% reduction in mowing frequency and eliminating the routine use of fertilizers and chemical herbicides. Harrison showed that sustainable vegetation management could reduce statewide vegetation management costs from \$33 million to \$23 million while lowering per-acre maintenance expenses to \$281.

With respect to ecosystem services, Harrison applied the benefit transfer method to quantify their impact under the current management regime as well as a program that combined sustainable vegetation management with an emphasis on wildflower plantings. The most significant ecosystem services along ROW landscapes include pollination, insect services, carbon sequestration, improved air quality, and resistance to invasive species. A previous study, for example, demonstrated that Florida crops pollinated by honeybees have an economic impact exceeding \$3.3 billion and generate nearly \$200 million in tax revenues. Another key benefit of roadside vegetation is runoff prevention, including erosion control, limiting pollutants entering streams and lakes, and flood mitigation. Harrison found that under FDOT's current vegetation management regime, the value of ecosystem services furnished by SHS roadside ROW landscapes topped \$547 million. According to his calculations, shifting to sustainable vegetation management could double or triple that figure. The most valuable benefit of ROW ecosystems is dampening runoff, a function Harrison valued at over \$465 million; he projected sustainable vegetation management combined with planting 1,000 acres of wildflowers could double the value of ecosystem services and increase the value of pollination and insect services between 50% and 95%.

While FDOT has generalized policies related to mowing (see next paragraph), the agency adopts a decentralized approach to establishing mowing procedures. Individual agency districts are responsible for coming up with their own mowing programs and policies. In 2014, a policy was proposed that would have reduced mowing by 10%, with

the aim of realizing potential annual savings up to \$1 million. Districts were given the option to reduce mowing, however, the degree to which mowing has been reduced varies throughout the state as the amount of mowing needed to preserve vehicle safety is not the same everywhere. Across the state, the agency is dedicated to preserving a safety strip of neatly mown vegetation adjacent to roads. Conversations with FDOT staff revealed that the agency's central office lacks the capacity to see whether and to what extent districts have cut back on mowing. All mowing is contracted out, however, FDOT reported no blowback from contractors over mowing reductions where they have occurred. One challenge noted by agency staff is that contractors will sometimes mow over areas with wildflowers because maintenance personnel lack the proper training to recognize species that should be avoided. Even so, contracts do not currently include penalties for mowing in restricted areas. A key aim of mowing operations is to mow only before and after the period of Monarch Butterfly migration (the agency is participating in the CCAA). Along with the economic savings promised by reduced mowing, wildflower associations have encouraged the use of altered mowing practices to facilitate the growth of pollinator-friendly species.

FDOT's vegetation management guidance specifies two types of roadside maintenance operations: T-1 and T-2. T-1 operations are meant to control the growth of planted and/or natural grasses, weeds, and other vegetation to preserve motorist safety and maintain an attractive roadside. Roadside areas that are mowed include front slopes, ditch bottoms, and backslopes (if present); areas adjacent to residential and commercial properties (only on arterials); intersections and other hazardous locations; and urban areas. The normal roadside mowing limit is 5 feet beyond the top of the ditch backslope if the backslope is less than 5 feet high. If the backslope exceeds 5 feet in height, the mowing limit extends 5 feet up the face of the backslope (from the bottom of the ditch). In normal fill sections where slope mowing is not required, mowing is limited to a maximum of 5 feet beyond the toe of the fill slope. On steep slopes, if the distance from the pavement to the ROW line is less than 70 feet or if ROW is adjacent to residential or commercial property, the entire ROW is mowed. Conversely, if the distance from the pavement edge to the border of the ROW is greater than or equal to 70 feet or if the ROW adjoins agricultural or undeveloped property, mowing is done between 5 and 10 feet beyond the shoulder or guardrail. Medians less than 70 feet wide are mowed in their entirety, however, if median is 70 feet or greater in width, the designated clear zone is mown, and remaining plots of native growth or grass should be at least 10 feet wide. Mowing operations are scheduled based on several considerations, including seasonality, location, turf condition, and climatological conditions. T-2 operations are conducted in areas which are not typically mown with the goal of encouraging natural growth. Areas that come under the purview of T-2 operations may also be appropriate for planting native trees, shrubs, and groundcover acclimated to the local environment as this can reduce mowing commitments and maintenance costs. If compatible with existing maintenance routines, T-2 zones may also be useful for cultivating wildflower sites.

For roughly 70 years, FDOT has overseen a wildflower program. Wildflower areas are locations within the ROW that contain naturally occurring, restored, or planted native flora with varying degrees of aesthetic vibrancy. While some plots require little more than species-specific mowing practices, others may need more intensive management. Wildflower areas also encompass locations where the desire or opportunity exists to manage naturalized species or establish or restore native wildflower meadows by sowing seed. The agency's preference is to increase wildflower numbers through the management of naturally occurring roadside areas. The State Landscape Architect and Office of Maintenance coordinate activities of District Wildflower Coordinators (DWCs). Wildflower areas are documented in district-level vegetation management plans. DWCs work with District Maintenance Engineers to ensure mowing frequencies in wildflower areas are described in a vegetation management plan as well as maintenance contractor documents. These documents specify that herbicide applications within 100 feet of a wildflower area are to be coordinated with the DWC. Each year, FDOT purchases roughly \$100,000 in wildflower seeds. It has developed guidance for establishing new wildflower areas from seed. Seeds may be planted in existing new planting areas and new construction zones. Contractors working on new construction projects will not do any plantings (they are added later), and they have limited responsibilities for the installation of landscape features. With respect to public outreach, the agency maintains its Wildflower Program website, which includes photographs of wildflower areas, and coordinates with organizations with an interest and expertise in wildflowers. Although at one time FDOT had a more aggressive public outreach campaign, it stopped distributing informational materials in response to budget cutbacks. Some local wildflower groups work on outreach. If motorists have questions — or complaints — about wildflower areas or mowing practices, agency personnel will respond and provide whatever information is needed to address the concern.

2.5 Pennsylvania

The Pennsylvania Department of Transportation (PennDOT) manages 112,000 acres along state-owned ROWs. It has recently established a Voluntary Prelisting Pollinator Conservation Program (PCP), the goal of which is to institute conservation measures that will preserve the habitats of key pollinator species that are not currently listed as threatened or endangered under the Endangered Species Act (ESA), but which may be listed in the future – these include the Monarch Butterfly, Yellow Banded Bumblebee, Regal Fritillary, and Frosted Elfin Butterfly . This program is focused on the state’s rural highways, which encompasses approximately 58,000 acres. Landscapes in urban areas are excluded from the program because they are less likely to sustain pollinator habitat. Annual mowing programs are devised by District Roadside Specialists and Highway Maintenance Managers, building off of generalized guidance released by PennDOT. The agency relies on a mixture of contractors and in-house staff for mowing. Some districts do not use any contract mowing. While the number of acres mowed by contract personnel fluctuated between 40,000 and 60,000 acres between 2014 and 2018, the overall trend was downward over this period.

PennDOT released updating mowing guidelines in March 2020 (Table 2.2). Four mowing types have been adopted by the agency, with Type C (i.e., conservation) being the most recent addition. As part of its PCP, the dates for Type F mowing have been adjusted. Previously, Type F mowing was performed after July 1, whereas now it is done after the growing season concludes or during a brief window in the summer. Safety clear zones typically extend 30 feet from the pavement edge and are maintained for adequate sight distance and visibility, which requires more frequent mowing and control of woody plants. Guidance states that grass should not be cut to more than 1/3 of its height and never to a height of less than four inches (for small operations). The preferred mowing height is between 8 and 12 inches. For Type C mowing these numbers are slightly different — the minimum mowing height is five inches, with a preferred height of 10 to 12 inches. The typical mowing width on uncurbed two-lane highways extends from the shoulder to ditch line plus one mower width up the backslope. Just under 30,000 acres on PennDOT’s rural ROWs are designated for single-pass mowing. Roughly 14,600 acres contains suitable pollinator habitat (i.e., neither in the clear zone nor forested). Conservation mowing will help to alleviate damage to valuable pollinator habitat. Estimates have found that mowing ROW in areas beyond required clear zones during the April 1 – October 1 period negatively affects up to 6,000 acres and 348,000 milkweed stems annually.

Table 2.2 PennDOT Mowing Operations

Mowing Type	Operational Description
C	<ul style="list-style-type: none"> Undertaken at interchanges and along the right shoulder beyond the clear zone and extending to the mow or ROW limits. Adopted to inhibit the growth and spread of weeds and other undesirable plants and to maintain early successional pollinator habitats. Minimum mowing height is 5 inches, but a height of 10 to 12 inches is preferable. Only done between June 20 and July 10 or after October 1 — each year or every other year.
L	<ul style="list-style-type: none"> Single-pass mowing done in areas immediately adjacent to the roadside. Right side of the travel lane is cut to specified minimum widths (between 5 and 10 feet).
F	<ul style="list-style-type: none"> Full-width, multiple-pass mowing undertaken once per year between October 1 and May 1, or between June 20 and July 10, to inhibit woody plant establishment and maintain a 30-foot recovery zone. Mowing heights are set between 8 and 12 inches.
G	<ul style="list-style-type: none"> Mowing behind guardrail using a boom mower to a maximum 8 feet. It is done once per year or every other year. Selective herbicide applications may complement or be a substitute for mechanical mowing.

A full treatment of PennDOT’s PCP is beyond the scope of this document, but some high-level details warrant discussion. The U.S. Fish and Wildlife Service (USFWS) has approved the program. A main goal of the PCP is to generate credits that will offset the taking of species once they are listed under the ESA. PennDOT and the Federal Highway Administration (FHWA) can use these credits during ESA consultations to mitigate the effects of transportation actions. Unlike the CCAA, which only covers maintenance activities and minor construction projects,

PennDOT's program covers construction on new alignments. Should one of the covered species be listed the agency is required to submit a program document, FHWA will request consultation, and USFW will issue a biological opinion. Then USFWS will determine which credits to accept. Voluntary conservation actions under the PCP include increased conservation mowing, continued daylighting of rural routes to promote milkweed and nectar-producing plants, and the installation of planted pollinator sites. PennDOT staff emphasized the importance of daylighting. Researchers have not paid significant attention to the role of daylighting in cultivating pollinator habitat (e.g., Thogmartin et al., 2017), however, this is likely because previous work has tended to focus on the Midwest. Pennsylvania has considerable forest cover and opening up the canopy has proven an effective strategy for encouraging the growth of pollinator-friendly vegetation. Another benefit of scaling back dense forest cover along roadways is that it can mitigate potential issues with snow and ice removal. The agency's conservation actions are supported through developing partnerships to foster habitat establishment; updated PennDOT publications, policies, and guidance; using a GIS Pollinator Prioritization Model; and adopting rapid assessment and monitoring protocols. A key focus of future monitoring will be on milkweed stem density.

PennDOT staff described a few best practices for agencies looking to adopt a conservation mowing program. Having strong buy-in from leadership and robust top-down enforcement are both critical for success. PennDOT's Deputy Secretary for Highways has championed conservation mowing and instructed district engineers to follow the newly released mowing guidelines. That being said, variability in implementation will inevitably exist across any state because cases will arise where mowing practices need to be adjusted to local context. As noted, while the agency expects to see significant cost savings from conservation mowing, because Type C mowing is in the process of being phased in, staff commented that it may take some time to get a sense of how significant the savings will be. PennDOT staff also noted that some mowing contracts run for five years. Existing contracts are grandfathered into the mowing guidelines in place when the contracts were signed. The agency is awaiting bids on new contracts, however, there has been some speculation that bids might increase (i.e., higher cost per unit effort) in response to the new guidelines.² Some personnel have also expressed concerns that contractors will lack the capacity to undertake mowing during the specified date ranges. Collectively, these issues suggest that it is important to consider how adjustments to mowing practices will influence contractor operations and bid prices. With respect to pollinator habitats, PennDOT staff commented that keeping them parallel to roads is a helpful strategy as this may lower insect mortality. Although the agency's conservation mowing is currently focused on rural areas, it is investigating if there are urban settings where reduced mowing would be appropriate. One type of location that shows promise is stormwater management facilities, which PennDOT is currently studying to determine whether they can be used as pollinator habitat.

PennDOT has also issued considerable guidance on pollinator habitat establishment and works with local groups through its Adopt & Beautify Program to create new habitat. The agency's Pollinator Habitat Plan focuses on the creation of naturalized gardens and meadows planted with pollinator-friendly plant species at designated sites. The plan lays out four goals: 1) support the establishment of seasonal flowers that host pollinators and apply integrated vegetation management to sustain them; 2) minimize vehicle/pollinator conflicts; 3) partner with community organizations through PennDOT's Adopt & Beautify Program; 4) install educational signage and publish literature and web-media information about pollinators and their habitats. Guidance recommends planting new habitat with diverse vegetation consisting of at least nine pollinator-friendly shrubs, legumes, or wildflowers to ensure sequential blooming. Wildflower plots are ideally sited in locations with high visibility (e.g., near the state border, gateways to cities, and major attractions) and should be at least 500 feet in length with a mow area retained between the edge of the road surface and wildflower plot. Once installed, plots are maintained via weed control (e.g., spot herbicide treatments), mowing (in the fall, after flowering has concluded), and re-seeding.

Another type of landscape PennDOT has installed is pollinator meadows, which are reserved for high-visibility areas in wide ROWs beyond the clear zone, interchanges, rest areas, and gateways to cities. These areas are larger than wildflower plots (minimum size of one acre), although like wildflower plots a mowed clear zone is preserved between roadway edges and meadows. Because it may take several years for pollinator meadows to flourish, guidance

² Staff recommended following up later this year to learn about the effects of conservation mowing on bid prices.

prescribes putting down an annual wildflower seed mix in the first spring for aesthetic purposes and a perennial pollinator seed mix in the second year. Pollinator meadows are maintained through spot spraying and mowing. During the establishment phase, the seeded areas should be mowed to a height of 10 to 12 inches at least once before early August to mitigate the pressure weeds exert on seedlings.

2.6 Indiana

The Indiana Department of Transportation (INDOT) manages approximately 60,000 acres of clear zone. It manages an additional 50,000+ acres outside of clear zone. The agency uses three types of mowing contracts: one focused on urban interstate systems, which encompasses nine urban settings across the state; another for the remainder of the interstate system; and a final type for US and state routes. Mowing frequencies are the highest along urban interstates (see below). In 2019, INDOT adopted new mowing practices, which increased the number of mowing cycles in urban areas while the number of mowing cycles on all other roadways was unchanged. Even with more frequent mowing in some areas, the mowing expenses fell slightly between 2018 (\$14.5 million) and 2019 (\$12.5 million). Standardized mowing widths and cycles across the state have helped keep costs down. The expenses for herbicide applications over the same period increased from \$2.6 million to \$4 million due to an uptick in both the number of acres treated as well as the frequency of use. Alongside the implementation of new mowing practices in 2019, INDOT began to contract out the majority of mowing activities and herbicide applications — previously the agency had relied on a mixture on in-house personnel and contractors. Several issues motivated the decision to outsource all mowing. Relying on in-house forces for all mowing would have required costly investments in new equipment (e.g., replacing aging equipment). Another consideration was the potential to reallocate tens of thousands of personnel hours to other maintenance activities. Further, shops and mechanics would no longer focus energy on the repair and upkeep of mowing-related equipment. Factoring in equipment depreciation and overhead revealed the cost of in-house mowing and contracting mowing to be equivalent.

INDOT’s vegetation management guidance designates three management zones (Figure 2.1). Zone 2 includes the clear zone and highway medians. These areas are mowed five times per year in urban areas, three times per year on rural interstates, and twice yearly elsewhere. Mowing extends outward from each shoulder 15 feet; medians 60 feet or narrower undergo full-width mowing — previously only medians 45 feet or less were mowed in their entirety (the upward revision has occurred in the past year). While all of Zone 2 is treated with broadleaf herbicides, just the first 15 feet are maintained with mowing. In Zone 3 (the Selective Zone), the agency applies selective herbicide treatments and limited mechanical treatments (e.g., spot mowing, mechanical woody biomass reduction) with the goal of facilitating native herbaceous plant growth and controlling undesirable species.

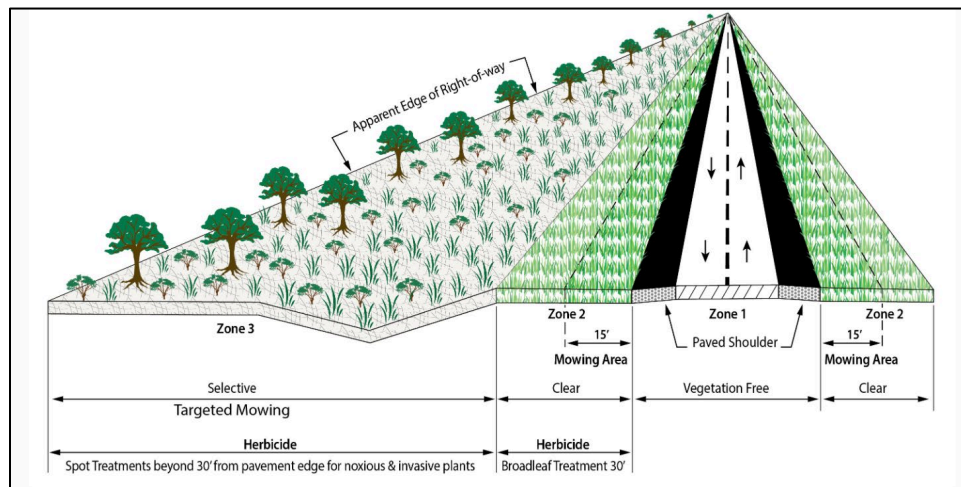


Figure 2.1 INDOT Vegetation Management Zones

As noted, INDOT saw its expenditures for herbicide treatments escalate considerably in 2019. There are a few reasons for this change. Previously, when in-house personnel were responsible for the herbicide program, not all of the locations slated for applications in a year would necessarily be treated (e.g., due to logistical challenges or other factors that precluded staff from getting to these areas). Contracting out the herbicide program has helped to routinize it because Contractors are obligated to complete the activities. Another factor has been an increase in spot treatments and reductions in broadcast applications. While spot treatments are very effective at doing targeted weed control, they are also more expensive to execute — spot treatments run approximately \$100 per acre, whereas broadcast applications average \$60 per acre. One aim of the broadleaf weed control program is cutting back mowing frequencies and ensuring there are year-over-year declines in weed populations within the mowing zone/area. Something that may help with this in the long-term is a program introduced in 2019 to map the location of problematic species throughout the state as well as trees and adjacent land uses. This program is run by a contractor; the maps that are generated can be updated each year to track changes in species distributions and identify emerging hot spots. While INDOT is facing some challenges with respect to quality assurance and quality control of the mapping, staff observed that even imperfect information (e.g., inaccurate species identifications) can be useful for deepening their understanding of how many acres are occupied by species and to develop more accurate treatment plans and budget estimates. The agency is hopeful that year-over-year improvements in mapping techniques will gradually reduce the number of errors. When asked if herbicide treatments will be lessened in the near future, INDOT staff said that 5 to 10 years will likely need to pass for self-sustaining vegetation communities take hold and predominate (after which reductions are possible).

INDOT is working to expand its number of wildflower plantings and participates in the CORRIDORS Program, a consortium of Indiana state government agencies whose goal is to cultivate habitat for wildlife and pollinator-friendly vegetation. Currently, one INDOT district has a dedicated wildflower program, and the agency intends to establish a statewide budget line item for wildflowers. These efforts will focus on both nectar-producing plants and milkweed species. Agency staff observed that the diversity of nectar-producing vegetation along state-owned ROWs has increased because of reduced mowing cycles. However, they also cautioned that cutting back on mowing can increase the abundance of undesirable species, so it is important to practice adaptive management and identify the appropriate combination of mowing and herbicide treatments to foster desired roadside vegetation communities.

On the public outreach front, agency staff encouraged DOTs to develop stronger communications strategies to inform the public about vegetation management. INDOT is trying to publicize its vegetation management strategies through social media, however, because district offices run their own accounts, statewide coordination can be challenging. A more foundational issue is that not everyone uses social media, which makes it important to convey messages through multiple outlets. One potentially helpful strategy is to develop knowledge articles that customer service representatives can consult when they receive phone calls from the public. These pieces describe the logic underpinning the agency's vegetation management decisions. Following the adoption of new mowing practices in 2019, INDOT did not record increase in calls, which it views as a success. Similarly, a recent customer satisfaction survey found that the percentage of satisfied and dissatisfied respondents with vegetation management was equal — which staff also viewed as an indicator of success. An important emphasis of any communications plan, according to agency personnel, is letting the public know that plan is in fact in place to manage vegetation and that it may take several years for desired plant communities to take hold. A key long-term goal is to gain public acceptance of native vegetation communities — including low scrub and wildflowers where they are ecologically appropriate and are compatible with safe roadway operations — as these species communities are much less expensive to maintain and are ecologically/environmentally very important. Ultimately, the agency wants to get to the point where it can manage all acreage using the same principles irrespective of lies next to it.

2.7 Maryland

The Maryland State Highway Administration (SHA) manages approximately 55,000 acres. Each year, the agency spends roughly \$1.5 million on herbicide treatments and plant growth regulator (PGR). A significant portion of this budget is dedicated to noxious weed control as mandated under state law, while the remainder goes toward the control of broadleaf weeds and brush. Although the agency introduced changes in its mowing policy in 2010, SHA staff noted that it has pursued several previous efforts to reduce mowing. Some of these initiatives date to the 1970s and 1980s and were launched in response to high fuel prices. While the agency has adopted the use of meadow

plantings for a considerable period of time, the 2008 spec book outlined guidelines for incorporating self-sustaining flowering plants into roadside landscapes. It has encouraged the public to embrace roadsides with mixed vegetation communities. The SHA relies on a mix of contractors and in-house maintenance staff to execute its mowing program. Level of contract mowing varies by maintenance shop, with some rural areas doing almost all mowing with in-house staff.

Table 2.3 summarizes the Maryland SHA’s mowing practices by priority area as published in the agency’s 2003 guidance, *Integrated Vegetation Management Manual for Maryland Highways*. SHA staff, however, observed that a new manual is currently going through the vetting and approval process — its *Landscape Management Guide*. The information presented in Table 3 is included for informational purposes only and does not reflect current practices. In 2010 the agency introduced a new policy to clarify where mowing is to be performed; it resulted in the SHA mowing 33,000 fewer acres and generated savings of \$3.5 million which were redirected toward other maintenance activities. Currently, all mowed areas are classified as short or tall meadow. Short meadows are located within 10 feet of the outside edge of the shoulder and undergo mowing an average of three times per year. Tall meadows are located beyond this 10-foot threshold and are generally mowed once per year during the winter. The agency’s new guidance will attempt to adopt a context-sensitive approach to green asset management. For example, tall meadows are maintained on an individual basis according to geometric constraints and speed limits — the American Association of State Highway and Transportation Officials (AASHTO) *Roadside Design Guide* informs these decisions as it specifies clear zone ranges based on design speed, slope, and other factors. Safety is thus an overarching consideration in how tall meadows are managed. Along with ensuring adequate clear zone in tall meadows, the SHA is also careful to ensure sufficient mowing is done in submerged areas and in places where signage must remain visible. In addition to controlling vegetation by mechanical means, PGR is sometimes used in short meadows. Special attention is paid to controlling Johnsongrass, Canada Thistle, and Phragmites in tall meadows. SHA staff also commented that the agency has stopped using glyphosate around guardrails and avoids using chemical treatments that leave bare ground, which produces soil erosion — this supports ongoing efforts to reduce sediment inputs into Chesapeake Bay.

Table 2.3 Maryland SHA Priority Area Mowing Practices (c. 2003)

Priority	Locations	Mowing Height (In.)	Notes
1	<i>Facilities</i>		
	<ul style="list-style-type: none"> Information Centers, Rest and Picnic Areas, Weight Stations, Curbed Medians, Islands Park and Rides 	<ul style="list-style-type: none"> 2.5-3 3.5-4.5 	Mow entire area except for those designated as a No Mow Area
	<i>Residential and Commercial Areas</i>		
	<ul style="list-style-type: none"> Roadsides, Interchange Triangles, Medians < 72’ Wide 	<ul style="list-style-type: none"> 3.5-4.5 	Mow all areas with a slope ≤ 3:1 unless designated as a No Mow Area
	Interchange Loops	3.5-4.5	Mow 20’-24’ from the curb or 12’-16’ from the shoulder’s outside edge
	Medians ≥ 72’ Wide	3.5-4.5	Mow 20-24’ from the shoulder’s outside edge
2	<i>Non-Residential and Non-Commercial Areas</i>		
	<ul style="list-style-type: none"> Roadsides and Interchange Triangles Medians < 40’ Wide Medians 40’ to 72’ Wide 	<ul style="list-style-type: none"> 3.5-4.5 3.5-4.5 3.5-4.5 	<ul style="list-style-type: none"> Mow 12’-16’ from the shoulder’s outside edge Mow the entire area Mow 12’-16’ from the shoulder’s outside edge
	Traffic Barriers, Shrubs, Wildflowers	3.5-4.5	Mow to the front side

	Selected Meadows, Wildflower Sites, Areas Adjacent to Cultivated Fields	5-7	Mow once per year in late June; if a second mowing is needed, perform in the fall
3	3:1 Cut Slopes (When Ditch is Within 30' of the White Edge Line)	<ul style="list-style-type: none"> 3.5-4.5 	Spot mow trees and brush 5-7' above the ditch line from July through October

* Guidelines from 2003 *Integrated Vegetation Management Manual for Maryland Highways*

While the Maryland SHA has a long-standing commitment to fostering diverse vegetation communities, the agency released a pollinator habitat plan in 2017 following passage of the Pollinator Protection Act. The plan focuses on the cultivation of designated pollinator habitat sites around the state. The plan's three goals for enhancing pollinator habitat are: 1) Establish seasonal flowers that provide nectar, pollen, and nesting sites for pollinators; 2) Create refuge areas with plants and seeds not treated with neonicotinoid pesticides, and 3) Install educational signage about pollinators and their habitat. Pollinator habitat plantings have been and will be installed in areas that raise public consciousness; SHA staff commented that it is important for pollinator gardens to be highly visible to give people the opportunity to learn about the benefits of pollinators. The agency also has a webpage on pollinators which is intended to be minimalistic. Apart from these designated areas, SHA staff noted that hundreds of acres have been planted with diverse meadow seed mixes. However, one problem the agency confronts on highway contracts is that knowledge about what species will be available is often uncertain, so the tendency is to rely on the same 20 or so species.

Alongside its pollinator initiative, the SHA recently funded a study that examined the impacts of different vegetation management regimes on floral abundance and diversity as well as bee abundance and diversity (Kuder 2019). A key finding of this investigation was that the number of floral species was higher in plots that underwent a fall mowing or selective herbicide use than in areas where conventional turf management practices were adopted. Plots treated with fall mowing or selective herbicide treatments also exhibited greater plant biodiversity. The performance of these two treatments, however, was statistically indistinguishable. In areas where fall mowing or selective herbicide treatments was used, natural regeneration of wildflowers occurred (Kuder said these plants may have been in the soil seed bank due to previous efforts by SHA). With respect to bee abundance and diversity, the study concluded that plots where fall mowing was done had more bees than plots where selective herbicide applications or conventional turfgrass management strategies were adopted. Bee diversity seemed more influenced by the characteristics of the surrounding landscape.

2.8 Missouri

The Missouri Department of Transportation (MoDOT) manages nearly 400,000 acres along its state-owned ROWs. The agency's current vegetation management policy was phased in around 2011 and 2012. Like many other state transportation agencies, coming out of the Great Recession MoDOT sought ways to reduce costs, finding mowing was one area in which savings could be realized. Agency staffers observed that the new policies reduced the number of acres being mowed and that even today MoDOT remains committed to further cutting back mowed acreage. Efforts to plant native grasses and wildflowers predate these changes, however, and stretch back at least 20 years. While agency staff did not have access to exact figures, mowing reductions have lowered costs, although some of the savings have been invested in herbicide treatments (often required when mowing is done less frequently) and other areas. Mowing frequency varies throughout the state, with up to six mowing cycles per year in urban areas; elsewhere, landscapes are maintained with three mowing cycles. MoDOT uses a mixture of in-house personnel and contractors for mowing. Contract mowing occurs primarily in and around the state's urban centers — St. Louis, Kansas City, Columbia, Springfield — while in-house personnel are responsible for most rural locations. Although the entire Interstate 70 corridor was at one time mowed by contractors, this is no longer the case as contractor availability along rural stretches is limited and contractors find operating in more isolated settings difficult (e.g., due to costs and the logistical challenges of staging equipment). MoDOT staff noted that 15 to 20 years ago, contractor prices tended to be less than or on par with the cost of in-house staff. Since then, prices have risen. Even so, the agency views contracting out some of its mowing as useful because it frees up in-house staff to work on other activities (e.g., pavement-related issues).

Table 2.4 reproduces key facets of earlier MoDOT’s mowing practices from its 2003 *Roadside Vegetation Management*. The paragraphs following this table describe the agency’s current mowing protocols. Several changes are worth highlighting. First, the 2003 guidance established mowing practices for four area types, however, the most recent guidance appears to leverage a simplified approach and reduces this to three: major roads, minor roads, and high-profile areas. Another major difference is that with the exception of undeveloped areas on undivided highways the 2003 guidance generally prescribes mowing a 30-foot-wide swath from the pavement edge, while the current policy calls for mowing a 15-foot strip (at least during the first two mowing cycles). How medians are treated has also undergone considerable adjustments. Previously, vegetation was controlled on the entirety of medians less than 100 feet wide. Now, full mowing is only done the first two cycle on medians less than 60 feet wide (see below for additional details).

Table 2.4 Missouri DOT 2003 Mowing Guidelines

Area	Locations and Maintenance Practices
High-Profile Areas	<ul style="list-style-type: none"> • Encompasses raised medians, islands, roadside parks, commuter parking lots, and other high-profile areas with significant pedestrian traffic • Vegetation kept between a height of 4 and 8 inches, typically using walk-behind mowers, lawn -type mowers, and line trimmers
Fully Developed Areas	<ul style="list-style-type: none"> • Includes fully developed areas on all routes • Vegetation is maintained at a height between 6 and 12 inches; mowing begins when 50 percent of vegetation grows to a height of 12 inches • Entire ROW should be mowed, let to naturalize, landscaped, or some combination of these practices
Undeveloped Areas on Divided Highways	<ul style="list-style-type: none"> • Includes all undeveloped area on divided highways • Vegetation is maintained at a height between 6 and 18 inches; mowing begins when 50 percent of vegetation grows to a height of 18 inches • On medians < 100 feet wide, vegetation is controlled via PGR and mowing • District offices can decide how to manage vegetation on medians that are between 100 and 150 in width (varies by terrain) • On medians > 150 feet wide, vegetation control extends inward 30 feet from the edge of the traveled way • At interchanges vegetation is controlled from the edge of the roadway outward 30 feet • On main roadways vegetation is controlled from the edge of the roadway outward 30 feet
Undeveloped Areas on Undivided Highways	<ul style="list-style-type: none"> • Vegetation maintained at a height between 6 and 18 inches; mowing begins when 50 percent of vegetation grows to a height of 18 inches • Vegetation control should extend between 6 and 15 feet from the edge of the shoulder • A final mowing extending 30 feet from the shoulder edge can be done each season once there is little likelihood of significant regrowth.

Currently, on major roads MoDOT mows three times per year (Figure 2.2). The minimum mowing height in these areas is 6 inches. On steeper slopes that do not require mowing, the agency plants wildflower and native grasses (i.e., pollinator-friendly vegetation). Vegetation along medians and the outer shoulder receive different treatments. During the first and second mowing cycles — which occur in mid-May and mid-July, respectively — crews mow areas extending 15 feet from the edge of the outer shoulder. A third mowing cycle in mid-September expands the area which is mowed. Areas stretching up to 30 feet from the edge of the outer shoulder are mowed. Selective herbicide applications are permissible in locations extending up to 50 feet beyond the outer shoulder. If a median is less than 60 feet wide, it is mowed in its entirety during each mowing cycle. For medians wider than 60 feet, mowing occurs along a 15-foot-wide strip along the inner shoulder in each direction. During the final mowing cycle, all medians

narrower than 100 feet are completely mowed while along medians wider than 100 feet a 30-foot-wide swath is mowed. The interior portions of wider medians are reserved for wildflowers and native grasses. At interchanges, vegetation within 15 feet of the pavement edge is mowed, but these locations are evaluated on an individual basis to determine precise mowing requirements.

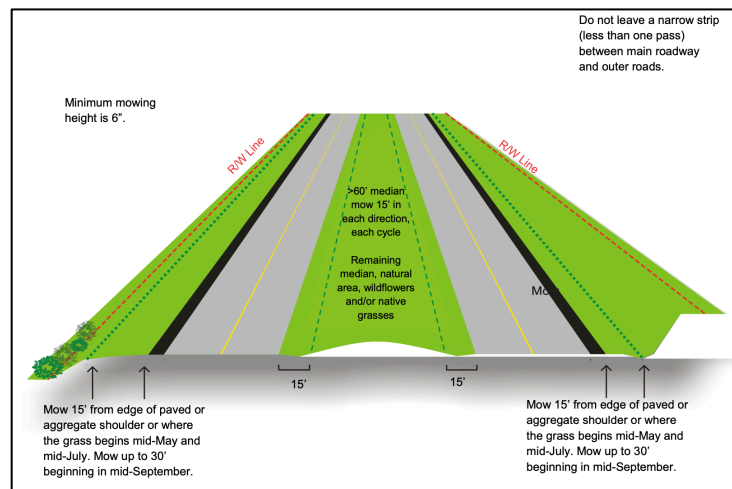


Figure 2.2 Missouri DOT Mowing Technique on Major Roads

In high-profile areas (see Table 4 for definition), vegetation is kept in a turf-like state of repair and maintained at a height between 4 and 8 inches. Vegetation on minor roads is maintained at a height between 6 and 18 inches; mowing commences when 50 percent of the vegetation attains a height of 18 inches and is concentrated in an area extending 6 to 15 feet from the shoulder edge. The option exists to do a final mowing each season on flatter slopes. In odd-numbered years, a final mowing can occur on a 30-foot-swath adjacent to the shoulder, while in even number years it is limited to 15 feet. Selective herbicides are used in areas within 30 feet of the shoulder to control heavy brush. Steeper slopes are planted with native grasses, wildflowers, and pollinator-friendly vegetation. Guidance contains a provision which states that the number of mowing cycles may be revised and coordinated throughout the state if conditions warrant.

rural

After mowing frequencies were reduced, MoDOT staff commented that the agency received some complaints from the public, however, many reacted favorably (roughly a 50-50 split between positive and negative sentiment). MoDOT has not conducted significant public outreach to inform the public of its landscape management practices and their underlying strategies. Information is available on its website about the agency's commitment to native vegetation and wildflowers, but it has been a number of conservation-oriented groups throughout the state which have invested considerable effort into outreach, informing the public about the importance of native vegetation communities, and even conducted some landscape management. For example, the Missouri Prairie Foundation has received grant money from the Missouri Department of Conservation to mitigate the spread of invasive species. MoDOT has also established some pollinator gardens throughout the state. At one point, the agency also sponsored a research project to develop geospatial inventories of roadside vegetation (somewhat comparable to efforts in Indiana and Washington), however, it was limited in scope. MoDOT staff nonetheless felt that adopting this approach, when combined with new spraying technologies, could greatly benefit landscape management efforts.

Ultimately, agency staff commented that it is important to keep highway ROW maintained as well as possible, but it that is also critical to reserve sufficient budgetary resources for addressing pavement- and safety-related issues. While a number of the conversations with state transportation agency staff were conducted against the backdrop of the COVID-19 shutdown, MoDOT personnel were the first to express uncertainty about where vegetation management will go in the future given the deep and inevitable contractions in discretionary spending most agencies will endure.

2.9 Wisconsin

The Wisconsin DOT (WisDOT) manages over 150,000 acres of land, and since the 1950s has abided by what the agency calls a natural roadsides philosophy, which prescribes mowing only where necessary to maintain safety. The aim of this philosophy is to protect, restore, and maintain native plants and native plant communities with the goal of preserving Wisconsin’s native landscape, efficiently managing vegetation along highway ROWs, and increasing the level of enjoyment among travelers. A unique feature of WisDOT’s vegetation management program is that the agency contracts out all mowing activities to individual county highway departments (think of this as dealing with 72 subcontractors). Like many other state transportation agencies, in 2009 WisDOT further reduced mowing in response to loss of revenue stemming from the Great Recession. Before these changes went into effect, the agency did long-line mowing along rural highways twice per year (see definition below). New guidelines stipulated one long-line mowing per year and mowing vision corners on an as-needed basis. In 2009 the Invasive Species Rule (Wisconsin Admin. Code NR 40) was also signed into law, which mandates the control of non-native invasive species. To comply with this law and ensure budgets are not exceeded, the Bureau of Highway Maintenance collaborates with the Department of Natural Resources (DNR) to develop mowing practices. Agency staff estimated that less frequent mowing stemming from the 2009 policy change roughly halved mowing expenses.

In 2014 WisDOT further adjusted its mowing policies, which resulted in separate practices for urban and rural settings. This change was partly driven by stakeholders expressing concern that mowing reductions negatively impacted visuals and aesthetics in some communities; WisDOT also received some complaints about medians that were mowed once per year. Establishing a new policy for mowing in urban areas did not significantly influence costs, however, staff commented that mowing expenses have crept up between 15% and 20% in recent years. Some of these increases have been the product of inflation. But they also observed that capturing any more cost savings will be difficult given the reductions that have already been made. Further retrenchment may be possible through leaving certain areas un-mowed for specified lengths of time, but this would probably yield limited savings.

For the purposes of setting design and management objectives, current mowing policy divides roadsides into two zones — a clear zone, in which vegetation is closely managed to ensure safety is preserved, and what is called the natural roadside, which encompasses locations beyond the clear zone and is given over to native and low-maintenance vegetation.

In rural areas, the beginning of mowing season is contingent on location and growing conditions. In the lower third of Wisconsin, mowing should be completed by July 1; in the central portion of the state it is July 15; and in the northern tier it needs to be finished by August 1. Invasive species are mowed before going to seed and during periods of low energy reserves (which mitigates propagation). The agency does what it calls long-line mowing once per season in rural areas. This entails mowing a 15-foot-wide strip immediately adjacent to the outside shoulder and a 5-foot-strip along inside shoulder to a height of 6 inches. Mowing for safety purposes is executed whenever needed to maintain adequate sight distances and along curves. However, mowing is not typically undertaken to meet aesthetic objectives. Every three years mowing is done throughout the entire clear zone to reduce woody vegetation. Clear zone width varies by road design class and whether a section is at-grade, cut, or fill (see Table 2.5). Nothing beyond the edge of the clear zone is mowed. In newly seeded areas, to reduce competition from weeds mowing occurs during the first two growing seasons; the mowing height is also set at 6 inches in these locations.

Table 2.5 Wisconsin DOT Rural Area Clear Zone Widths

Design Class	At Grade or Cut Sections	Fill Sections
No Design Class • 22’ pavement; less than 6’ shoulders	15 feet	15 feet
A1 • 22’ pavement; 8’ shoulders	25 feet	30 feet
A2 • 24’ pavement; 8’ shoulders	30 feet	35 feet
A3 • 24’ pavement; 6’ inside shoulders; 10’ outside shoulders	35 feet	45 feet

A4 & 5 • 26-40' pavement; curb, gutter, and no sidewalk	8 feet	8 feet
A4 & 5 • 26-40' pavement; curb, gutter, and beyond sidewalk	6 feet	8 feet

WisDOT's urban mowing policy contains guidelines for urban state trunk highways and controlled-access highway interchanges and access roads. State trunk highways have the following characteristics: 1) not a designated connecting highway; 2) ROW is within a municipality designated as municipal extension; 3) roadway encompasses curb and gutter sections, medians, and roundabouts; and 4) speed limits of 50 mph or less. Mowing commences on state trunk highways when vegetation is nine inches high. Mowing along outside shoulder cuts extends either to the ROW line or 30 feet from the curb and gutter (whichever distance is less). On state trunk routes, the aim is to not exceed 10 mowing cycles per year, and nothing outside of the specified clear zone widths is to be mowed. All turf grass areas within medians, grass islands, and roundabouts are mowed. Given how frequent mowing occurs along these roadways, woody vegetation growth is uncommon. If it becomes necessary to mow woody vegetation, approval must be obtained.

For controlled-access highway interchanges and access roads, WisDOT requires the development and maintenance of detailed urban mowing maps. Mowing begins in these areas once vegetation reaches a height of 18 inches, while vegetation should not be mowed to a height less than six inches. On the outside shoulder, mowing extends to the bottom of the ditch or 30 feet from the finished shoulder point. In infields, mowing stretches a maximum of 30 feet from the finished shoulder point; woody vegetation beyond the clear zone is allowed to remain. Along medians, mowing is performed from ramp terminal to ramp terminal or maintenance crossover to maintenance crossover. Each spring, urban mowing perimeters are established during the first mowing cycle and remain fixed throughout the season — expanding these areas can result in the dispersal of invasive species. The agency's goal is to limit controlled-access highway interchanges and access roads to six mowing cycles per year. Similar to rural areas, mowing for woody vegetation in the clear zone may be done once every three years, although given the higher mowing frequencies it is less likely that woody vegetation will gain a foothold. Figure 2.3 depicts the location of the features mentioned above for a diamond interchange.

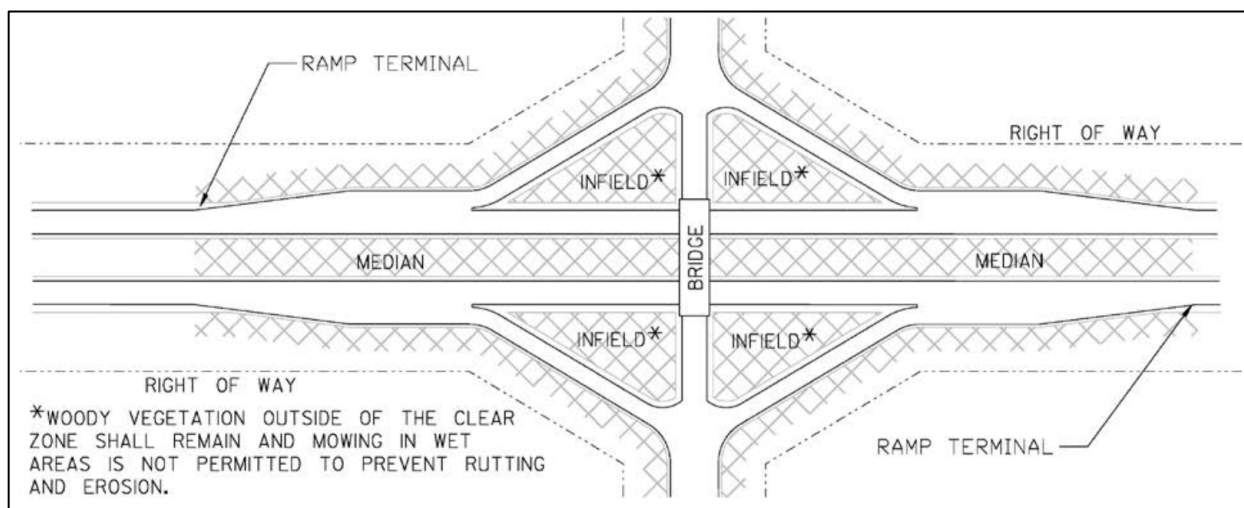


Figure 2.3 WisDOT Interchange Mowing Locations

WisDOT has a number of pollinator-related initiatives. In addition to preserving prairie remnants along highway ROWs, the agency is working to establish new prairie vegetation communities. Often it is challenging for prairie plants to take hold on roadsides, however, once they mature and become well-established they generally perform well. At several rest areas prairie demonstration gardens have been installed, and new signage is in the works to inform the public of the benefits conferred by pollinator-friendly vegetation. Agency staff also mentioned crafting educational and outreach initiatives designed to help the public understand the importance of native plants and

pollinator habitat. The agency is collaborating with at least one utility company to identify areas where pollinator-friendly vegetation can be installed underneath transmission lines located on WisDOT ROWs. Other notable activities include the use of a special seed mix in vegetated areas on the Zoo Interchange project in Milwaukee as well as ongoing work on the Interstate 39 corridor (between Madison and the Wisconsin-Illinois border) to use native seeds and native woody plants. WisDOT staff said that it is important for transportation agencies to receive buy-in from stakeholder groups when they introduce new vegetation management strategies. Communications with the public need to emphasize the long-term benefits of mowing less and using native plantings (e.g., erosion control, control of invasive species).

2.10 Nebraska

The Nebraska Department of Transportation (NDOT) times mowing with an eye toward promoting the health of roadside flowers and ensuring they can produce adequate seeds to regenerate. Shoulders and medians are mowed to preserve adequate sight distance and enough room for vehicles pulling off the road. Ditches and backslopes are only mowed between October 1 and May 1 as this not only lets desirable grasses reach a state of dormancy or set seed, it also protects pollinators and Monarch Butterflies. Where mowing operations aim to control the production of weed seeds — and where there is no desirable vegetation — the mowing should occur while plants are flowering and before seed development. Mowing heights are never less than six inches as this avoids exposing bare soil and damaging the crowns of native grasses. Along shoulders, the first mowing is scheduled for mid-May, while a second mowing in the middle of the summer is only used to correct sight distance problems. A third mowing after October 1 helps prevent snow accumulation on highway shoulders. Table 2.6 summarizes mowing practices by highway type. NDOT does occasional total mow-outs of state-owned ROWs. Roughly 1/5 to 1/4 of total mileage in a maintenance area undergoes this procedure each year. The recommended mow-out frequency varies geographically — in the eastern portion of the state the suggested mow-out frequency is once every four years; it is once every five years in much of the central region, and it is done on an as-needed basis to the western part of Nebraska.

Table 2.6 Nebraska DOT Mowing Practices by Highway Type

Highway Type	Mowing Practices
Urban Interstate and Expressways	<ul style="list-style-type: none"> • Mowed as frequently as needed to keep the landscape appearing neat
Rural Interstate and Expressways	<ul style="list-style-type: none"> • Minimum mowing width of 5 feet along the median and outside shoulders • Maximum mowing width of 8 feet where wildflowers are present • Where no wildflowers are present, the maximum mowing width is 15 feet • Mowing height should never be less than 6 inches
Rural Primary and Secondary Roadside Areas	<ul style="list-style-type: none"> • No mowing is allowed on slopes • Mowing height should never be less than 6 inches, and vegetation should be maintained at a height between 6 and 12 inches
Shoulder Mowing Widths	<ul style="list-style-type: none"> • Surfaced Shoulder <ul style="list-style-type: none"> ○ Minimum mowing width is 5 feet; maximum width is 15 feet • Turf Shoulder <ul style="list-style-type: none"> ○ Mowing width is 15 feet (except where this presents a hazard to the operator or public) • Wildflowers Present <ul style="list-style-type: none"> ○ Where adopting a mowing width of 15 feet will impact flowers reduce width to 5 feet or 8 feet until blooming has concluded
Sandhills Region	<ul style="list-style-type: none"> • Vegetation should be maintained at a height of 15 inches

	<ul style="list-style-type: none"> • Mowing should occur on or around July 1; additional mowing may be done after October 1 for snowdrift control • Mowing widths on highway shoulder areas limited to a minimum distance of 5 feet and a maximum distance of 15 feet beyond the roadway edge
--	---

NDOT’s mowing dates and frequencies are designed to minimize interference with pollinator life cycles and foraging activities. Agency staff also collaborate with pollinator interest groups throughout the state and work with these groups to devise action plans and policies to support pollinator life cycles and foster habitat expansion. On construction projects, NDOT uses seed mixes on foreslope, ditch, and backslope (FDB) areas — which stretches from 16 feet away from the pavement edge to the ROW boundary — that incorporate taller species and wildflowers. Some FDB areas are planted with dense patches of wildflowers (termed wildflower islands). Seed mixes used in these areas away from the highway shoulders can consist of 10-20% wildflowers.

In keeping with other state profiles that discussed research funded by agencies, it is worth briefly reviewing the findings of an NDOT-commissioned study which examined whether conventional seed mixes that incorporate wildflowers are more or less successful at establishing wildflowers than planting wildflower patches (Wu-Smart and Schact 2019). Researchers investigated the performance of four treatments: 1) conventional seeding; 2) 50% conventional seeding, 50% of area seeded in two strips with a pollinator mixture of wildflowers; 3) 50% conventional seeding and 50% wildflowers in a single patch; and 4) entire backslope planted with wildflowers. Conventional seed mixes proved less adept at fostering wildflower establishment than densely seeded patches of wildflower stands. However, it is possible that the number of forbs in smaller patches will decline over time due to grass encroachment. A positive correlation was detected between wildflower establishment and the number and diversity of bees, but treatments did not differ significantly with respect to species numbers and diversity. As with other guidance, researchers noted that it is important to develop seed mixtures that contain a variety of forbs which bloom sequentially as this will sustain different bee communities throughout the season. Another goal should be to progressively refine seed mixes by identifying and removing wildflower species that do not perform well while increasing the number of those which are successful.

2.11 Texas

Among state transportation agencies, the Texas Department of Transportation (TxDOT) likely has the longest established wildflower program in the country. Since the 1930s, the agency has delayed all mowing until the spring and early-summer wildflower seasons wrap up. TxDOT, which currently manages around 800,000 acres, uses its wildflower program to harmonize the ROW with adjacent lands, reduce erosion rates, lower maintenance costs, and improve aesthetics and wildlife habitat. In particular, the agency’s strip and safety mowing practices (see below) have been developed to promote native grasses and wildflower growth. Throughout the state, district maintenance engineers are tasked with evaluating all unpaved sections of agency ROW to determine where non-mow or natural areas should be located and calculate the number of acres that will undergo various types of mowing. These figures are then used to prepare contract bid proposals and estimate maintenance costs.

TxDOT has guidelines for each type of mowing it performs — modified full-width mowing, strip mowing, and spot mowing (done for safety purposes). Table 2.7 summarizes the characteristics of each practice. In rural landscapes, non-mow and natural areas are established to facilitate wildflower propagation, native grass regeneration, and provide wildlife opportunities for nesting. Signs are installed in these areas which instruct maintenance personnel to avoid mowing. In rural areas, up to two modified full width mowing cycles per year are allowed, with an additional strip mowing permitted in the southern portion of the state because of its longer growing season. Vegetation should not be mowed to a height less than seven inches, which preserves wildflowers and aids the regrowth of native grasses and nectar-producing plants. The first modified full-width mowing should be delayed until wildflower seeds have the chance to mature and reset, while the second iteration of this cycle does not occur until late fall as this affords native grasses ample opportunity to regenerate, preserves nesting cover, and reduces plant competition. During strip mowing and spot mowing operations, a 30-foot-wide swath is mowed at rural medians and outer separations — unless the grade is too steep or there are plants that have wildlife benefits, mitigate erosion, or foster

pollinators. Most often, strip mowing is done on fill sections and cut sections, however, at deep cuts mowing extends across the ditch line to the beginning or base of the backslope. Mowing operations are scheduled to achieve coordination with seasonal cycles and other roadside maintenance activities.

Table 2.7 Texas DOT Mowing Practices

Mowing Type	Description
Modified Full-Width Mowing	<ul style="list-style-type: none"> • Encompasses all of unpaved ROW except for locations designated as non-mow or natural areas. In fill areas, the latter typically begin at the toe of the slope; in cut areas they begin at the back of the ditch. • Along rural roadways with very wide ROWs or medians, mowing extends a maximum of 30 feet from the road’s edge.
Strip Mowing	<ul style="list-style-type: none"> • Mowing extends 14-15 feet from the edge of the shoulder. Along with mowing this strip, strip mowing operations also include: <ul style="list-style-type: none"> ○ Mowing from the pavement edge to the ROW line in developed areas ○ Mowing where needed to maintain adequate sight distances (e.g., at intersections, private entrances, curves) ○ Mowing around features such as signs, delineators, and guardrails that are located within the mown strip ○ Mowing the entirety of medians ≤ 15 feet and outer separations ○ Full-width mowing from ROW line to ROW line for drainage where it is necessary ○ Mowing transitions to ensure the mown strip dovetails with other areas which require greater or lesser mowing widths
Spot Mowing for Safety	<ul style="list-style-type: none"> • Done on an as-needed basis to preserve adequate sight distances for inside curves, off-ramps, on-ramps, intersections, private entrances, signs, delineators, and other roadside features. This type of mowing is usually done when safety issues arise between strip mowing cycles.

Texas is renowned for the springtime appearance of its highways, which are full of vibrant and colorful wildflowers. Each year, the agency plants roughly 30,000 pounds of wildflower seeds. Researchers at Texas A&M have helped the agency develop guidelines for planting seeds and with matching wildflowers to growing conditions. It is critical to select native plant seeds and choose species which are adapted to local soils, moisture conditions, and growing season. Each TxDOT district has access to wildflower seed lists to help staff choose appropriate species (information is published on each flower, mixture rates, single seeding rates, and locations where they thrive).

2.12 Virginia

Hoping to reduce mowing expenses during the Great Recession, the Virginia DOT (VDOT) first revised its vegetation management practices in 2009. A policy published in 2010 based on the practices instituted in 2009 tied mowing and litter pickup service levels to road system type and average daily traffic counts. These practices reduced mowing expenditures from \$32.1 million to \$18.1 million while not compromising safety, clear zones or sight distance requirements. This also coincided with staff reductions at the agency.³ In 2011, VDOT released its best practices for mowing, which apply to interstates, primary, and secondary roadways. As these are currently in effect, they are the focus of this discussion. Although the agency publishes best practices for rural and urban mowing, they are substantively quite similar (Table 2.8). While VDOT uses a mixture of in-house personnel and contractors for mowing, agency staff commented that the majority is contracted out. A mandate requires that interstate maintenance be privatized. As with most agency maintenance programs, safety takes precedent at VDOT. And the agency is careful to ensure no sight distance issues are present or any other problems arise which could imperil motorists. Agency

³ The 2009 policy is listed in the references section. Because this document does not reflect VDOT’s recommended best practices with respect to mowing frequencies, we do not include the service level matrix here. https://www.virginiadot.org/projects/resources/VDOT_VegetationMgmtPolicyFinal_VDOTwebsite.pdf

staff also emphasized that while most districts do a good job adhering to the published best practices, the practices lack the force of laws or regulations. As such, some variability is bound to occur in their application.⁴

Table 2.8 Virginia DOT Mowing Practices

Location	Summary of Practices
Rural and Urban Medians	<ul style="list-style-type: none"> • Medians \leq 50 feet wide with a 3:1 slope or flatter with a vertical drop $<$ 7.5 feet are mowed in their entirety. • For medians \leq 50 feet wide with a slope $>$ 3:1 with a vertical drop $>$ 7.5 feet, mowing is done from the pavement edge to 5 feet behind guardrail (in fill areas) or to the ditch (in cut areas). • Medians $>$ 50 feet wide with a 3:1 slope or flatter with a vertical drop $<$ 7.5 feet are mowed from the pavement edge to a distance of 18 feet. • For medians $>$ 50 feet wide with a slope $>$ 3:1 with a vertical drop $>$ 7.5 feet, mowing is done from the pavement edge to 5 feet behind guardrail (in fill areas) or to the ditch (in cut areas).
Rural and Urban Outside Shoulders	<ul style="list-style-type: none"> • Where the slope is 3:1 or flatter, mowing is done from pavement edge outward 18 feet or to 5 feet beyond the ditch line. • Where the slope is $>$ 3:1, mowing is done from the pavement edge to 5 feet behind guardrail
Rural and Urban Additional Mow	<ul style="list-style-type: none"> • Mowed on average once every 3 years or when non-desirable species or woody vegetation has taken hold and requires removal.

Although the best practices are intended for statewide application, District Administrators have the discretion to adjust mowing practices to preserve safe clear zones and sight distances. Vegetation should be mowed on medians, interchanges, and roadside areas on an as-needed basis to maintain mowing height ranges, while plants found around signs, guardrails, delineators, mailboxes, bridges, and intersections are to be maintained to the same standard as roadside they are located on. Figure 4 captures how mowing is timed in each of VDOT’s nine districts as well as mowing height ranges. The goal of the first mowing cycle is to cut vegetation while plants are producing seeds. By doing this, mowing spreads seeds and expands desirable turf species. Typically, vegetation reaches a height of 10-15 inches prior to the first mowing. The purpose of the second and third mowing cycles is to meet minimum business requirements. If mowing is done more frequently in urban or suburban areas, documentation must be submitted to justify increased expenditures. The date ranges listed in Figure 2.4 were calculated based on 30-50–year climatological averages for Growing Degree Days (GDD); they are based on the GDD needed for most seed head to forms but not fully mature.

District Region	Mowing Height Range ^{4,5}	Primary Roadside Turf Species ^{6,7}	Timing			
			First Mowing Range (control grass growth and promote overseeding) ⁸		Second Mowing Range (control herbaceous weeds) ⁹	Third or Last Mowing Range (control woody growth) ^{9,10}
			Not before	Prior to		
Bristol, Staunton	4" to 6"	Cool	May 10	June 10	late July to late Aug	mid Sept to late Oct
Salem, Lynchburg, Culpeper	4" to 6"	Cool	May 5	June 5	late July to late Aug	mid Sept to late Oct
Richmond	4" to 6"	Cool	May 1	June 1	late July to early Aug	mid Sept to late Oct
	2" to 4"	Warm	May25	--	--	After Aug.30
Hampton Roads	4" to 6"	Cool	April 20	May 20	early July to early Aug	late Sept to late Oct
	2" to 4"	Warm	May 10	—	—	After Sept. 20
Fredericksburg	4" to 6"	Cool	May 5	June 5	late July to late Aug	mid Sept to late Oct
	2" to 4"	Warm	June 5	—	—	After Aug 30
N. Virginia	4" to 6"	Cool	May 5	June 5	late July to late Aug	mid Sept to late Oct
	2" to 4"	Warm	June 5	—	—	After Aug. 30

Figure 2.4 Virginia DOT Table of Mowing Dates (2010)

Figure 2.5 visualizes the mowing techniques summarized in Table 8. One item not addressed previously is what the agency terms *additional mow areas*, which are located outside of the areas maintained using the management techniques summarized in Figure 4. On average, additional mow areas are mowed approximately every three years. However, they are sometimes mowed more frequently to control the encroachment of woody vegetation and species that are not desirable. To protect valuable pollinator habitat, these areas are only mowed between November 1 and March 31. In areas which undergo regular mowing cycles, if pollinator species are identified, and retaining them will not present a safety issue, they should be mowed during the November 1 – March 31 period. (VDOT staff mentioned that it is challenging for crews to identify and subsequently avoid these species during routine mowing.)

VDOT staff also touched briefly on the challenges of non-native and invasive species, noting that most noxious weeds and invasive species are treated when the agency receives requests from the public — such as when a farmer complains about Johnsongrass on adjacent ROWs. Most of the agency’s focus is on selective treatments and preventing emergent invasive species just entering the state from gaining a foothold (e.g. Japanese Stiltgrass, Giant hogweed). Invasive species, such as trees of heaven and Johnsongrass, are now ubiquitous enough that the agency lacks the resources that would be needed to eradicate them.

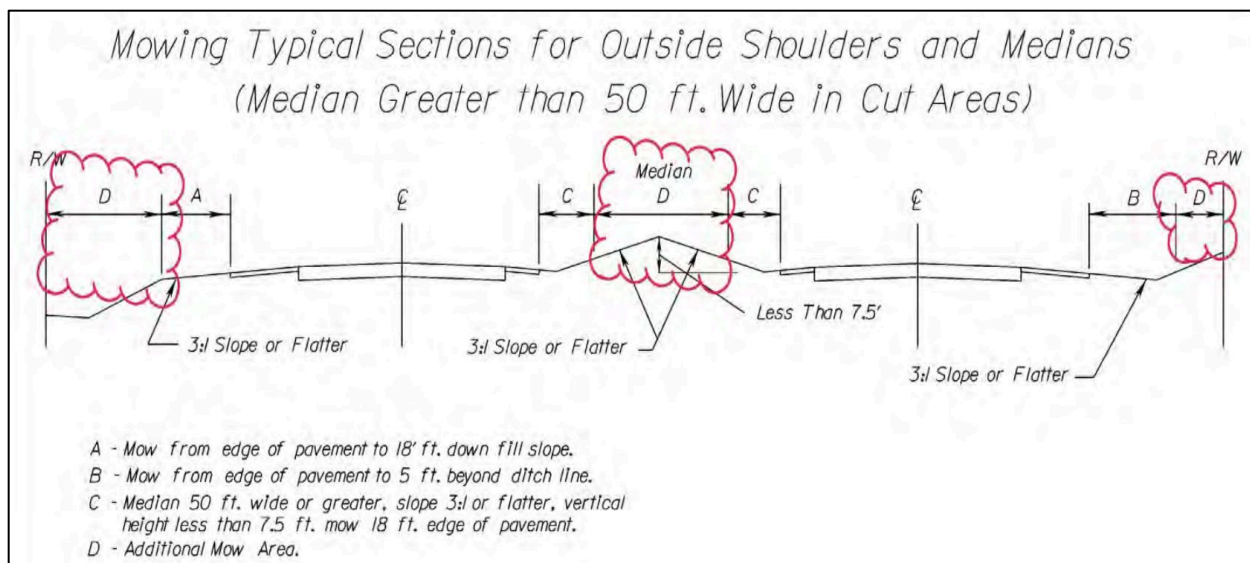


Figure 2.5 Virginia DOT — Example Mowing Section

VDOT launched its Pollinator Habitat Program in 2014 with a focus on installing naturalized areas planted with pollinator-friendly and native nectar-producing vegetation along state-maintained roadways as well as at rest areas and park and rides. To date, most plantings have been installed in high-visibility settings like rest areas because they are easier to maintain than plots along roadways. The program has three goals: 1) Provide habitat areas for threatened and dwindling pollinator species (e.g., bees, butterflies); 2) Lower maintenance costs by reducing mowing and other vegetation management expenses (e.g., invasive species control, herbicide applications); and 3) Decrease erosion and stormwater runoff, provide sediment control, use fewer pesticides, and enhance aesthetics. Focusing work on high-visibility sites has been ideal for educating the public and promoting tourism through aesthetics. VDOT has also developed educational signage to inform visitors of the benefits conferred by pollinators and pollinator-friendly vegetation. Program activities are funded through specialty license plates, which generate revenues of \$240,000 per year.

In 2019, VDOT joined the CCAA and is currently in the process of enrolling its interstates in the program. The agency is also a member of and participant in the Virginia Pollinator Protection Strategy Advisory Committee, the goal of which is to protect managed pollinators, and partners with Blue Ridge PRISM (Partnership for Regional Invasive Species Management), which works to prevent the spread of invasive species and is developing strategies to create new native-rich seed mixes — which could be used on construction and maintenance sites. A new research project through Virginia Tech is surveying the state’s different physiographic provinces to both inventory existing plant life and determine how best to incorporating more native species into seed mixes. As staff commented, non-native species (e.g., fescue, ryegrass) are often used because they establish cover quickly and therefore mitigate erosion. At the same time, staff also commented that it is likely a lot of native species exist in the seed bank, which is promising.

With respect to implementing a reduced/conservation mowing program at state transportation agencies, VDOT staff said having a strong top-down message that filters down to the district level is critical for adopting new practices and changing mindsets. Deploying standardized practices and mowing dimensions fosters consistent applications of best practices, however, it is also important to give district personnel the leeway to adjust practices if needed to achieve management objectives (e.g., a practice that works in low-relief terrain characterized by a sub-humid climate would not be well-suited to mountainous areas with greater temperature variability). A final point VDOT staff emphasized was the need for strong educational outreach to inform the public of why it has adopted particular management strategies.

2.13 Minnesota

Minnesota is noteworthy because it has a law on the books pertaining to mowing operations in rural areas (MN Statute 160.232 — *Mowing Ditches Outside Cities*). This law stipulates that the 8-foot strip adjacent to the road surface or shoulder can be mowed at any time. The entire ROW can be mowed during the month of August, however, from August 31 to the following July 31, the agency can only mow the whole ROW to preserve safety (e.g., maintain sight distances). The first 8 feet adjacent to the shoulder is mowed before vegetation reaches a height of 12 inches. State-owned ROWs can also be mowed, burned, or tilled to prepare it for the permanent establishment of vegetation cover or for prairie vegetation management. Additionally, the statute instructs road authorities to use low-maintenance native vegetation which keeps mowing requirements to a minimum, supplies wildlife habitat (e.g., for pheasants), and ensures the safety of the driving public. The primary justification for not mowing ditches and backslopes until August 1 is to give nesting species adequate cover to nest during the spring and summer months.

Like many state transportation agencies, the Minnesota Department of Transportation (MnDOT) mows principally for safety reasons. More than 175,000 acres of green space abut the state's 12,000 roadway miles, with the agency responsible for mowing approximately 45,000 acres per year. Annual mowing frequencies range from 2 to 3 along shoulders to 10-15 at rest areas and buildings sites. MnDOT's *Mowing Smart* policy aims to keep mowing to a minimum in areas outside cities. Consistent with MN Statute 160.232, it recommends mowing the 8-foot-strip of vegetation adjacent to the shoulder before plants reach a height of 12 inches. At intersections, mowing is done to provide for good visibility. Similarly, mowing operations emphasize keeping signage, traffic signals, and other road markers visible, with approaches to road signs mowed to a distance of 500 feet if necessary. The interiors of curves are mowed as necessary to preserve sight distance. MnDOT's maintenance guidance further clarifies the approach to mowing. What the agency describes as normal mowing typically consists of a single pass extending from the top of the shoulder to the ditch bottom (although additional mowing is permissible to resolve issues with drainage, snow, and/or safety). Medians less than 55 feet wide are mowed completely, while if a median is more than 55 feet wide a strip along the inslope is mowed, similar to along shoulders. At-grade intersections are mowed as necessary to maintain proper sight distance, while woody vegetation can be installed at interchanges if adequate clear zones and sight distances are preserved. Vegetation management at roundabouts is similar to curve sections, with the middle of the central untraveled area kept at higher lengths compared to median, shoulder, or inslope grass heights. A complete mow out of the safety clear zone is completed every 2 to 3 years to inhibit the growth of trees and woody vegetation. When roadsides are mowed after September 1, mowing heights are kept in the range of 10-12 inches to provide cover for species that nest early in the spring. MnDOT relies on selective herbicide treatments to control noxious weeds (i.e., spot spraying), while spot mowing/shoulder mowing may be necessary to enhance sight distances or control snow drift.

MnDOT has adopted many strategies to benefit pollinator species, including the use of context-appropriate vegetation management policies. It entered into a partnership with state transportation agencies in Iowa, Kansas, Missouri, Oklahoma, Texas, as well as the FHWA, to both recognize and support Interstate 35 as a Monarch Highway. As part of this agreement, MnDOT in conjunction with the other agencies is working to establish and implement best practices to increase public awareness of the Monarch Butterfly, honeybee, and pollinator habitat in general. The Minnesota Department of Agriculture has also released best practices for improving pollinator habitat along roadsides and adjacent ROWs. Practices designed to mitigate negative impacts include not mowing weeds with ripe seed; early detection and control of invasive species; applying selective herbicide treatments before weeds flower; and working with adjacent landowners with particular management concerns. In terms of creating new habitat, suggested practices include protecting roadsides with native plant communities from invasive species and other disturbances; consistent with MN Statute 160.232, limiting mowing to the first eight feet of roadside inslope; delaying mowing beyond the statutorily prescribed date of August 1 to generate more food for pollinators, benefit wildlife, and give flowering plants the opportunity to set seed; using prescribed fires in prairie remnants to encourage native plant growth; and leaving dead trees in place on backslopes if they will not adversely impact the roadside or adjacent landowners (as they offer valuable nesting sites). The creation of pollinator habitat focuses on using native seed mixes during ROW construction or revegetation efforts; installing new pollinator habitat at protected locations (e.g., rest areas, weigh stations, stormwater ponds); and planting living snow fences with native grasses and flowers. MnDOT also works with the Minnesota Board of Water and Soil Resources and the Minnesota Department of Natural

Resources to develop 20 native seed mixes that are used on roadsides. A plant selection tool is available to MnDOT designers to help them select appropriate seed mixes for their project contexts.

2.14 Washington

The Washington Department of Transportation (WSDOT) manages approximately 100,000 acres along its roadsides. In 2015, the agency shifted to a reduced mowing program along wider ROWs to foster more natural aesthetics. These new vegetation management practices have resulted in considerable savings, approaching \$750,000 annually. Between 2015 and 2018, year-over-year costs for safety mowing have generally declined compared to the five-year average, with savings ranging from 1% to 20%; there was a slight uptick in costs in 2018. Nuisance weed mowing has declined in cost significantly over the same period; cost reductions compared to the five-year average over this period ranged from 50% to 70%. WSDOT is also working to create pollinator habitat and has created a web-based map which can be used to evaluate the suitability of road segments for pollinators (see below).

WSDOT divides the roadside into three zones: Zone 1 is a vegetation-free zone, Zone 2 is an operational zone, and Zone 3 is a transitional/buffer zone. Most high priority and routine maintenance activities occur in Zones 1 and 2 as these areas facilitate operational functions (e.g., traffic operations visibility, sight distances, surface and subsurface drainage). These zones also provide errant vehicles with ample room to recover if they depart the roadway. Zone 3 is only present if sufficient ROW is present beyond Zones 1 and 2.

Areas designated as Zone 1 are kept free of all vegetation. This zone begins at the pavement edge and extends outward. The optimum maximum width for this zone is two feet; or if hardware has been installed (e.g., guideposts, guardrail), it ends at the backside of that hardware. Maintenance is conducted more routinely in Zone 1 because it must be kept free of vegetation. The purpose of Zone 2 maintenance is to meet safety and operational objectives of roadsides. Unlike Zone 1, there is no fixed width for this zone. Instead, the optimal minimum width is dictated by clear zone vehicle recovery criteria. Where guardrail or concrete barriers have been installed, there may be no clear zone requirements. Zone 2 maintenance consists primarily of mowing and IRVM techniques, and its goal is to ensure vegetation does not negatively impact safety and operational functions. Zone 3 begins at the edge of Zone 2 or immediately behind guardrail or concrete barriers. Management of these areas encourages self-sustaining vegetation communities, with maintenance treatments being more selective.

Taking a closer look at 2019 IRVM plans from several of WSDOT’s districts clarifies how the general principles discussed above and summarized in Table 2.9 are converted into treatment plans. In Zone 1, herbicides are applied to road shoulders to preserve a band of gravel shoulder next to pavement that is free of vegetation. The herbicides are applied in fall or spring based on operational requirements, with supplemental treatments applied on an as-needed basis where vegetation is growing in cracks and joints. Safety mowing is performed in Zone 2 either once or twice per year to ensure adequate visibility, maintain roadside hardware and delineators, preserve adequate sight distances at curves and intersections, and enable drivers to identify approaching wildlife. Vegetation is mowed to a height of 6 to 8 inches, and mowing widths generally vary between 5 and 25 feet (depending on clear zone requirements). In both Zones 2 and 3, plans include directions for tree and brush control while hazard tree removal is only done in Zone 3. IRVM plans also contain provisions for the control of noxious weeds and nuisance vegetation.

Table 2.9 Washington DOT Maintenance Practices by Roadside Zone

Area	# of Acres Statewide	Maintenance Practices
Zone 1	6,500	<ul style="list-style-type: none"> All vegetation removed using mechanical or chemical techniques Requires more maintenance than other zones Two types of herbicide used: 1) non-selective herbicides that bind to the soil and suppress seed germination and 2) non-selective herbicides that remove existing plant material through application to the leaves and/or stem
Zone 2	33,500	<ul style="list-style-type: none"> Mowing and IRVM strategies used to preserve sight distance, facilitate vehicle recovery, and control weeds

		<ul style="list-style-type: none"> • Herbicide treatments are timed to avoid brownouts; flail or rotary-type side arm mowers should not be used if possible • Remove vegetation obstructions (e.g., trees with trunk diameters > 4 inches)
Zone 3	55,000	<ul style="list-style-type: none"> • Managed to be self-sustaining over the long term and blend in with surrounding vegetation; application of IRVM principles • Trees which pose a hazard by excessively shading pavement are removed • Wetlands, wildlife habitat, native plants, and wildflowers preserved

In addition to reduced mowing frequencies, WSDOT is taking a number of steps to expand pollinator-friendly habitat, including preserving areas of native habitat, managing roadsides for natural succession, establishing native plants and native flowering species, and incorporating more long-lived plants into landscapes that outcompete weeds while at the same time demanding little maintenance. Focal areas for pollinator-friendly habitat plantings include expansive ROWs, wetland mitigation sites, stream restoration sites, natural areas, and rest areas. The agency's guidance for developing pollinator habitat sites recommends planting an assortment of native flowers, trees, shrubs, and wildflowers. Ideally, not all flowers should bloom simultaneously — planting flowers that bloom sequentially supports pollinators throughout the season. WSDOT has developed regional charts which indicate during which time of year various species bloom. Rather than evenly distributing species across sites, the agency suggests installing patches of species to improve foraging opportunities. Leaving piles of brush and wood can also provide nesting spaces. Forbs and grasses should ideally be mowed in the late fall to prevent damage to flowering plants. But which areas should be prioritized for pollinator habitat? WSDOT has built geospatial models to pinpoint suitable pollinator habitat (Figure 6).⁵ The three models assign ranks to 0.5-mile highway segments based on how suitable they are for different types of pollinators. One model focuses on Monarch butterflies, a second on pollinator habitat, and the third on urban gateway pollinator habitat. Each model takes several variables into account to arrive at a ranking. For example, ranks for Monarch butterflies are calculated based on a road segment's proximity to suitable Monarch and milkweed habitat (defined by the USFWS's habitat suitability index model).⁶ An inventory-based approach like this can help agencies efficiently determine where efforts to create and/or maintain pollinator habitat are most likely to yield significant dividends.

⁵ The model is viewable at this link:

<https://www.arcgis.com/home/item.html?id=cb2ccf00e66e41c1b17aab97ec72f3f1>

⁶ Metadata for these models contains additional information on the factors which are used to calculate each. These can be accessed at:

https://www.wsdot.wa.gov/mapsdata/geodatacatalog/Maps/noscale/DOT_EAO/PollinatorHabitatRankings.htm

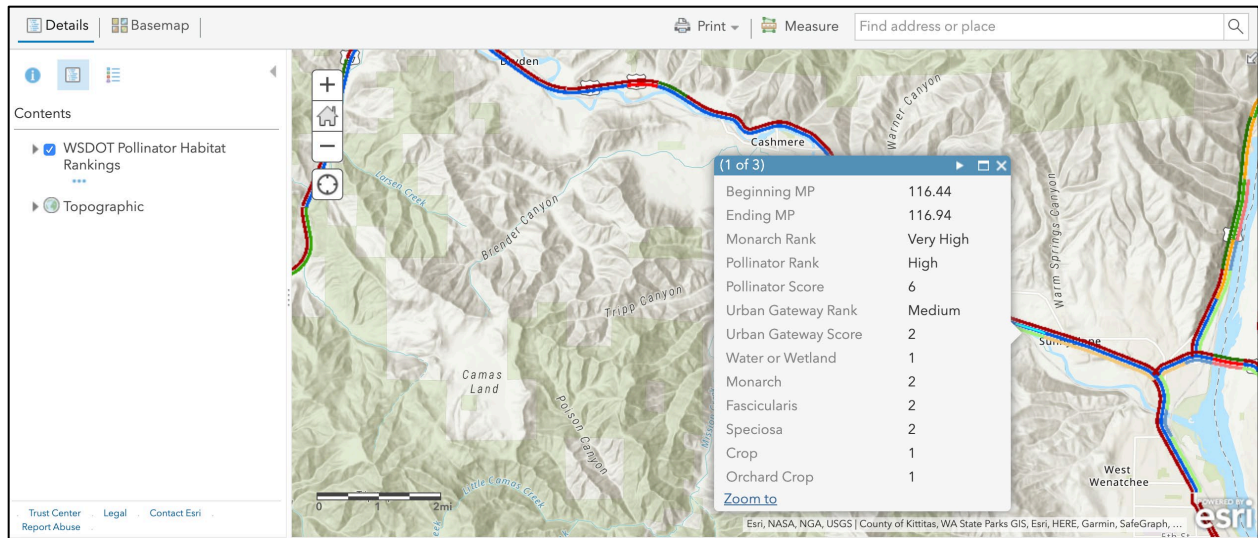


Figure 2.6 Washington DOT Map of Pollinator Habitat Rankings

2.15 Illinois

In 2017, the Illinois Department of Transportation (IDOT) introduced a new policy focused on reducing mowing frequencies. Dubbed Strategically Applied Vegetation Exemption (SAVE) Mowing, this program is focused on rural interstates. A primary goal of the program is to perform routine mowing on 15-foot swaths (i.e., safety strip) next to the roadway while mowing approximately 1/3 of the ROW outside of the safety strip each year. The cost savings realized from the new policy have been significant. Compared to 2016, mowing expenses in 2018 declined 34%, or \$4.6 million. In 2020, IDOT introduced the practice of applying plant growth inhibitor and broadleaf herbicides in the safety strip in some areas. Several counties were able to do without a first cycle of safety mowing as a result. Agency staff commented that they anticipate more savings as the use of growth inhibitors and broadleaf herbicides continues to expand throughout the state. How the SAVE Mowing policy works is that it can be applied when the following criteria are fulfilled:

- Access control fences are clean and free of invasive and volunteer trees and brush
- Ditch lines and drainage structures (e.g., wing walls, paved and riprap ditches, and ROW) from the 15-foot mow zone to the access control fence lack invasive and volunteer trees and brush
- Small woody vegetation that emerges after mowing is sprayed
- Noxious and invasive weeds have been eliminated and are monitored for reoccurrence
- Sections proposed for the exemption must be at least one mile long
- No mowing or environmental restrictions exist in the proposed sections
- Proposed sections have been coordinated with the District Landscape Architect or Roadside Manager and the District Operations Engineer have been forwarded to Central Office for approval at least two weeks before mowing begins.

Figure 2.7 depicts the manner in which SAVE Mowing is implemented through a three-year cycle and how IDOT achieves its goal of mowing 1/3 of ROW beyond the safety strip each year. Regardless of year, the 15-foot band of vegetation adjacent to the road can be mowed at any time to preserve sight distance and ensure motorist safety. First, invasive brush is removed from along the access control fence and herbicides are applied to any weeds. In Year 1, a 15-foot strip is mowed alongside the access control fence; weeds and woody growth in this area are treated with herbicides approximately 2-3 weeks after mowing is completed or as regrowth appears. In Year 2 a second 15-foot swath toward the ROW perimeter is mowed. This strip is located next to the area mown along the access control fence in Year 1. Finally, in Year 3 the remaining ROW is mowed out. Management mowing (i.e. SAVE Mowing, mowing done for brush management and around fixed assets [e.g., controller boxes, box culverts]) occurs between July 1 and August 15 as this produces food sources preferred by the monarch. There are several justifications for distributing a full mow-out of the ROW over a three-year period: it provides a habitat strip for ground-nesting birds;

extends bloom times and increases the availability of nectar resources for pollinators; gives insects which spend the winter in clumps of grasses, attached to stems, or inside hollow stems the opportunity to reach maturity; serves as a mechanism for naturally reseeding native forbs; and effectively controls invasive and volunteer trees and brush. IDOT also applies spot herbicide treatments as needed throughout the ROW as needed to ward off establishment of woody or invasive vegetation and eliminate the need for broadcast spraying. Another feature of the agency's mowing policy is a two-year mowing cycle along interstate medians and rural two-lane roads. Which means that in Year 1, medians wider than 40 feet are mowed out but two-lane roads are not, while in Year 2 mowing along two-lane roads is done on an as-needed basis while interstate medians are not mowed.

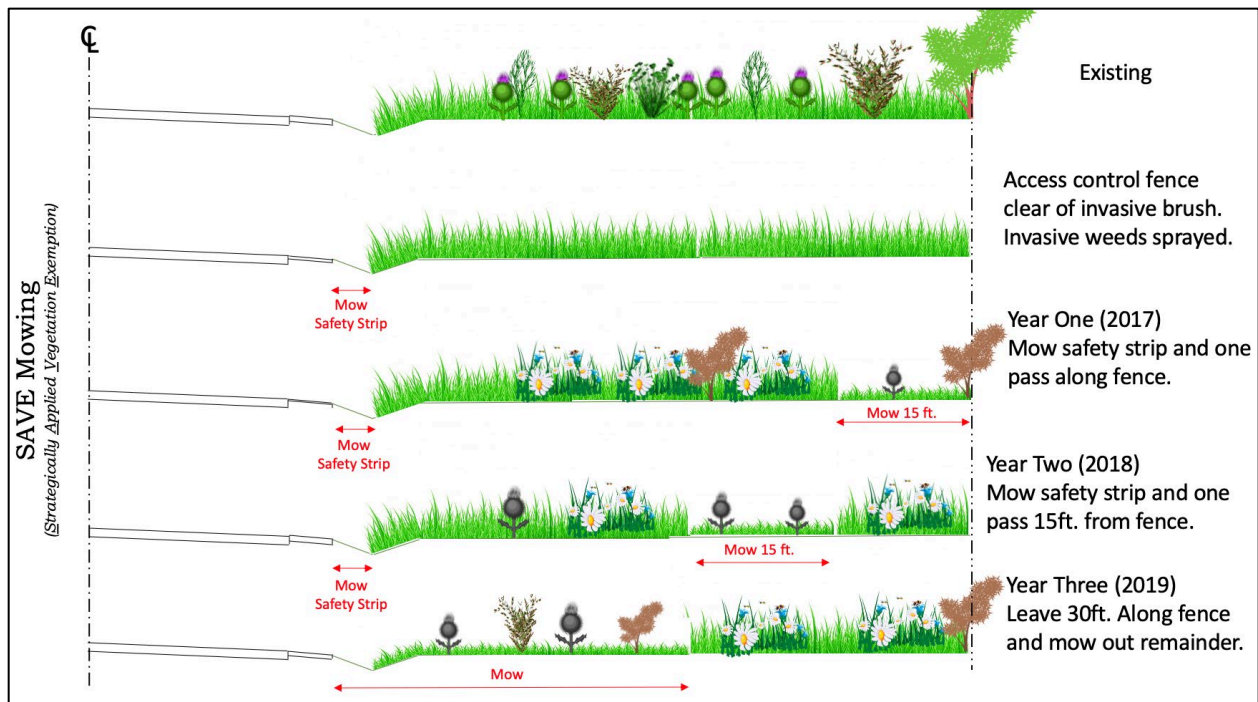


Figure 2.7 Illinois DOT SAVE Mowing Annual Progression

IDOT's SAVE Mowing policy has been approved by the USFWS, Bureau of Design and Environment, Illinois Department of Natural Resources, Illinois Monarch Project, Pheasants Forever, and other conservation partners. The agency's Operation Habitat, along with revised mowing policy, is working to expand the availability of pollinator habitat on state-owned ROWs. For example, IDOT has installed 24 Monarch Waystations on state land that are now registered with Monarch Watch, an organization dedicated to tracking the migration of Monarch Butterflies. The agency also collaborates with partners such as Pheasants Forever on the Illinois Route 66 Monarch Highway, the goal of which is to grow the population of monarchs. Additionally, IDOT partners with the Illinois Department of Natural Resources to distribute more than 7,000 seed packets containing milkweed and native flowers each year. With respect to other forms of public outreach and education, the agency takes advantage of social media to publicize its efforts, installs signage at Monarch Waystations, has staffed an Operation Habitat booth at the Illinois State Fair, and works with partners to get the word out about its efforts. To date, agency staffers have received few inquiries from the public about the new mowing practices.

The agency views district-level integrated roadside vegetation management (IRVM) plans as integral to its vegetation management program, although due to staff shortages preparing these has been placed on hold. Once they are developed, they will need to comply with standard mowing policies, although districts will be able to adopt individualized, context-sensitive management practices to control vegetation where needed. Agency staff observed that due to the decision on the Monarch listing being delayed that in 2019 and 2020 that IDOT was able to pursue more aggressive mowing along interstates to control brush.

Chapter 3 A Synthesis of Trends in Mowing Practice at State Transportation Agencies

The deluge of information presented in the last chapter may be slightly overwhelming. Here we strive to make sense of everything previously discussed by synthesizing key trends in mowing practices across state transportation agencies. Any agency working to establish a conservation mowing program would benefit from considering the concepts and practices outlined below.

3.1 Where and When to Mow

Figure 3.1 represents an (highly) idealized roadway cross section. It is divided into four zones. Each requires targeted management techniques.

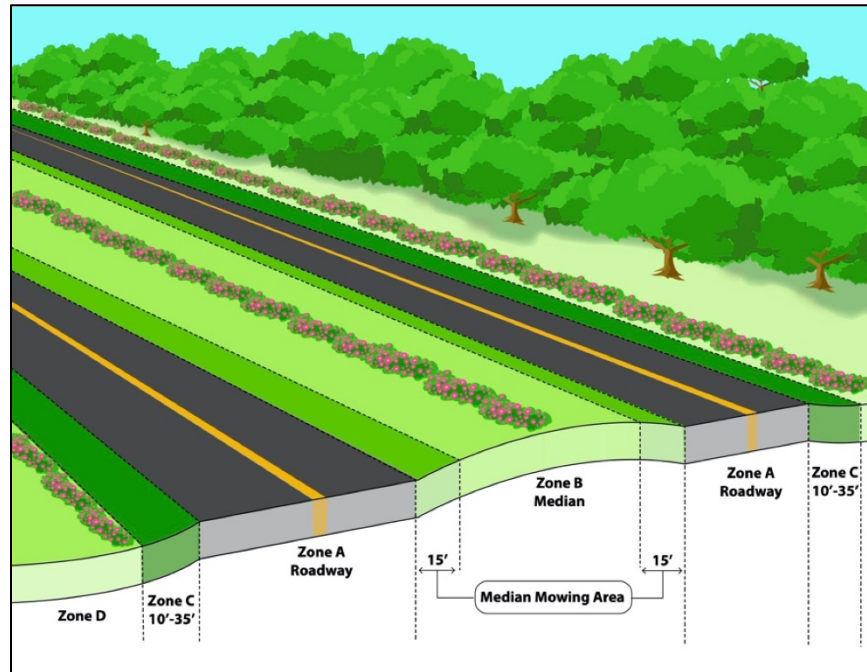


Figure 3.1 Idealized Vegetation Management Zones

Zone A — Roadway

The roadway (including paved and gravel shoulders) should be kept free of vegetation. Non-selective herbicides are applied to suppress emergences of plants and weeds in this area.

Zone B — Median

For medians exceeding a threshold width, approximately 15-foot-wide strips adjacent to the roadway are routinely mowed (e.g., 2-3 times per year or as needed to preserve adequate sight distances and clear zones). Plants should be mowed to a height of 6-8 inches to avoid inflicting damage. Other treatments which are appropriate in this area are plant growth regulator, which can slow the rate of plant growth, as well as selective herbicides. Median interiors are mowed once per year, typically in late fall, to guard against the encroachment of woody vegetation and encourage native plant growth. Selective herbicide treatments can also be used on median interiors to eliminate unwanted vegetation (e.g., invasive species, noxious weeds) and facilitate the propagation of native plants and wildflowers. Threshold widths vary by agency, with most stipulating that strip mowing should be used on medians that exceed a width of 40 to 70 feet. Narrower medians are mowed in their entirety during each mowing cycle to preserve adequate sight distances and sufficient clear zones.

Zone C — Clear Zone Along Exterior Shoulders (10-35 Feet from Pavement Edge)

A growing number of agencies are tailoring mowing practices to design clear zone widths along exterior shoulders (as specified in AASHTO's *Green Book*). Most commonly this takes the form of routinely mowing a 10- to 15-foot strip of vegetation next to the roadway surface (as with medians, *routine* denotes 2-3 times per year or as needed) and doing a complete mow out of the clear zone at least once every 2-3 years. The latter frequency varies, and several agencies undertake a full mow out every year. Native plants, wildflowers, and pollinators will realize the greatest benefits if the final mow is delayed until the fall. In Kentucky, this should occur after October 15. The first mowing in the spring should be timed to cut vegetation during seed production as this can facilitate overseeding. As with medians, areas in which strip mowing is used along outside shoulders may be treated with plant growth regulators or selective herbicides. Mowing heights should be at least 6-8 inches. Beyond the 10-15-foot strip, selective herbicides should be used to target noxious weeds and invasive species.

Zone D — Natural/Selective Management Area

Beyond the design clear zone, most agencies refrain from routine mowing. Some agencies (e.g., Illinois DOT, Virginia DOT, Wisconsin DOT) perform full mow outs of state-owned ROWs every 2-3 years. Common treatments include spot mowing, application of selective herbicides, and brush and tree trimming. Key management goals are eliminating undesirable species, encouraging the growth of native vegetation, and maintaining the landscape in as natural a state as possible.

Urban and Rural Mowing

Several agencies have developed separate mowing policies for urban and rural roadsides. Urban areas typically require more frequent mowing cycles to address safety requirements; urban landscapes also tend to be less suitable for pollinator habitat, although some agencies are examining the viability of installing pollinator-friendly vegetation in these areas.

Mowing Reductions and Herbicide Usage

Cutting down mowing frequencies will in all likelihood result in greater herbicide use, at least temporarily. The idea is that ramping up herbicide applications can suppress invasive species and noxious weeds and give native plants the opportunity to expand and thrive. How many years this will take is unclear, and it is likely that savings accrued from mowing less will at least be partially offset by the uptick in herbicide treatments. The potential thus exists for long-term savings and more robust native plant communities through a rigorous commitment addressing trouble spots with herbicides. As noted, selective herbicides are used in areas that undergo routine mowing (swaths adjacent to the roadway). Selective herbicide treatments are preferred on the outside portions of the clear zones and beyond, where the goal is to promote the growth of more native plants and wildflowers.

Supplemental Mowing

Agencies typically perform spot mowing around signs and other appurtenances located in areas where conservation mowing practices have been adopted to ensure these features remain visible to motorists.

Mowing for Safety

It is valuable to keep in mind that the foremost goal of mowing should be to keep the driving public safe. Mowing practices should therefore be designed around identifying locations in which routine mowing is essential for meeting this goal. An analogous framework to consider is Performance Based Practical Design, a roadway design philosophy which advocates a *design-up* approach. Meaning, the goal is to design a project that meets objectives and does not adhere to standardized design prescriptions — the application of which can be costlier. Likewise, in deciding where to mow, an agency should begin by figuring out which acres need to be treated with routine mowing and herbicide applications to maintain a sufficient clear zone and sight distances. Once these areas have been identified or typical mowing dimensions have been established for different road types, an agency can delineate acreage where mowing can be safely reduced and define appropriate treatments.

3.2 Implementing Conservation Mowing

Having strong buy-in from agency executive leadership is critical for getting a conservation mowing program off the ground and implemented consistently statewide. Likewise, standardizing mowing practices and cycles statewide will

yield the greatest benefits. It is equally important for leadership to convey a strong message to roadside maintenance personnel, one that underscores the imperativeness to adhere as closely as possible to recommended practices. That being said, staff responsible for overseeing mowing operations should be given the flexibility to adjust mowing practices in response to context. District-level staff are most attuned to the dynamics of local landscapes and thus best equipped to judge where context-sensitive modifications are required.

3.3 Communicating with the Public

Although many agencies that have introduced conservation mowing and pollinator habitat initiatives reported hearing complaints from individuals who prefer a manicured roadside aesthetic, they have also received compliments from numerous people who appreciate a more natural look and wildflowers. Being transparent with the public about vegetation management strategies is the first step toward gaining buy-in. Publicizing vegetation management plans in public-facing outlets (e.g., agency websites, advertisements, social media) keeps motorists apprised of what an agency is thinking and demonstrates a plan is in place to cultivate more natural-appearing roadsides. Another valuable strategy is to create knowledge articles describing how vegetation is managed which can be used by agency customer service representatives who field calls from the public. These articles will help representatives explain the reason for a more natural roadside appearance and can reduce the number of inquiries escalated to specialists. It is equally critical to call attention to pollinator initiatives (e.g., plots of pollinator-friendly vegetation on roadsides; plantings at rest areas, gateways, and other highway visible sites). Attractive signage, explanatory infographics, and solid branding can help alert people to and educate them about locations where agencies are promoting native plants and wildflowers and why they are doing it. Community outreach efforts should emphasize that it will take multiple seasons for the landscape to achieve an ideal, naturalized appearance.

3.4 Inventorying Green Assets

Inventories can potentially focus on several issues — suitable pollinator habitat, mowable acres, weeds and invasive species. The Washington DOT has developed pollinator habitat models which can be viewed online. As part of an NCRHP project Cariveau et al. (2019) developed several tools which can be adopted by state transportation agencies to improve roadside management for Monarch Butterflies. These include a landscape prioritization model, a method for collecting data in the field to rapidly assess roadside habitat for Monarchs, a roadside Monarch habitat calculator, and a set of best management practices. Any of these tools could be used to identify roadside areas most likely to support pollinators and pollinator-friendly vegetation. A few agencies require district-level personnel to calculate and inventory mowable acres (e.g., the number of acres in Zones A-D in Figure 8) as this can facilitate with contract bids and identifying locations where mowing can be reduced. Fine-grained mapping techniques have also been used by agencies to monitor vegetation assets, such as where invasive and noxious species are located. These efforts can pay dividends, but they will be expensive, and the accuracy of the knowledge generated is contingent on who does the mapping and their understanding of local ecological systems.

3.5 Interacting with Contractors and Maintenance Personnel

Most agencies depend on a mix of in-house personnel and contractors for mowing. Some agencies that have instituted reduced mowing frequencies reported seeing bid prices increase (either on a per unit basis or in other areas, such as litter removal). When introducing mowing reductions, it is important to closely track unit prices to control costs.

Another area of concern with contractors, but also in-house personnel, is mowing in areas that should be left untouched (e.g., wildflower stands). While no agencies we spoke with include penalty clauses in contracts if mowing occurs in a designated non-mow area, some noted that penalties may warrant exploration when signing onto an agreement such as the CCAA as this requires precise recordkeeping to track how many mitigation credits are earned. The foremost hurdle that must be overcome in this area is educating maintenance personnel on what different plants look like. Plant identification can be challenging even for experts trained in ecology or biology. This is an area in which mapping green assets could prove valuable. Developing information sheets that include pictures and descriptions of vegetation that should not be mowed is another way to address this issue. Trainings could also be used to educate maintenance staff on plant identification and techniques that should be used when navigating around non-mow areas.

3.6 Plantings and Seed Mixes

On construction or maintenance projects where seeding is required, agencies will benefit from using seed mixes that incorporate native plants along with a variety of pollinator-friendly wildflowers and shrubs in areas that will not be routinely mowed (e.g., outside of locations where strip mowing is used). It is important to choose species that bloom throughout the year. Including a mix of sequentially blooming vegetation ensures that pollinators can access nectar-producing plants and food resources throughout the growing season. Establishing plots rich in native vegetation from the outset also reduces mowing requirements over the long term.

Chapter 4 Analyzing and Projecting KYTC Mowing and Litter Removal Costs

To get a sense of how much KYTC could save by reducing mowing frequencies, we used contract data to 1) document how much the agency spent on contract mowing in 2019 and is slated to spend in 2020; 2) estimate how much can be saved by cutting out one Type 3 mowing cycle or converting one Type 3 cycle to a Type 2 cycle — as occurred in 2020; and 3) project savings over a five-year period. We also examined litter removal costs to forecast how much the Cabinet would save by nixing one litter cycle per year. Again, we projected these numbers over a six-year period to gauge medium-term savings from this adjustment. This chapter focuses on high-level statistics and findings. Readers should consult the accompanying Microsoft Excel workbook to examine calculations and inspect data on individual contracts.

4.1 Current and Projected Mowing Expenditures

The Cabinet has two types of mowing on the books. As listed in the *Maintenance Guidance Manual*, these are Type 2 and Type 3. Type 2 mowing entails mowing a 10-foot strip adjacent to the outside shoulder or pavement edge along roadways and interchange ramps, including all normal width medians. Conversely, Type 3 mowing involves mowing all areas that can be mowed out to the rights of way fence, mowing stake line, or some other designated limit. Many of the contracts KYTC enters into are based on three cycles of Type 3 mowing. However, the number of cycles varies from two to six, with more frequent mowing done in some urban areas and along interstates. Responding to budget reductions prompted by covid-19, in 2020 the Cabinet converted the first cycle of mowing throughout the state to Type 2. Remaining mowing cycles were left as Type 3.

Table 4.1 2019 Contracted Mowing Expenses

	Price Per Acre	Number of Cycles	Total Acreage	Total Expense
District 1	\$76.38	14	13,121	\$1,002,193.80
District 2	\$53.28	18	18,974	\$1,010,913.00
District 3	\$61.36	30	26,543	\$1,628,571.00
District 4	\$50.92	33	23,407	\$1,192,004.88
District 5	\$53.06	21	13,116	\$695,942.10
District 6	\$53.89	21	10,882	\$586,419.41
District 7	\$49.18	30	20,070	\$987,053.70
District 8	\$50.91	15	10,545	\$536,827.50
District 9	\$31.63	6	9,597	\$303,579.90
District 10	\$74.34	6	4,460	\$331,525.20
District 12	\$56.41	18	7,662	\$432,239.94
Interstates	\$42.59	62	73,972	\$3,150,655.44
Totals	\$51.04	274	232,349	\$11,857,925.87

Table 4.1 summarizes contract mowing expenses for 2019, while Table 4.2 lists figures that were originally projected for 2020 based on the assumption of all Type 3 mowing cycles. Compared to 2019, KYTC originally expected small increases in 2020 for price per acre, number of cycles, total acreage mowed, and total costs. Unit pricing was slated to increase 0.8%, from \$51.04 to \$51.46 per acre — slightly more than the current inflation rate of 0.6%. Overall, this translated into a roughly \$366,000 increase in mowing expenses. Table 4.3 presents forecast mowing expenses for 2020, following the conversion of one Type 3 cycle to a Type 2 cycle. For the year, total costs are just over \$10.5 million, which amounts to savings of approximately \$1.65 million (a 14.5% reduction). Another noteworthy difference is in mowed acreage. During a Type 2 cycle about 35,500 acres are mowed, while the number of acres mowed as part of a Type 3 cycle is more than double — 77,595. Next, Table 4.4 presents a more aggressive scenario for reducing mowing frequencies by estimating how much could be saved by cutting out one Type 3 cycle entirely.

We recognize this might not be feasible in some areas due to the risk of excessive vegetation growth and the problems which could arise when some areas are mowed once or twice per year (e.g., damage to equipment). Nonetheless, these estimates are instructive, and in some locations increasing herbicide applications to offset the impacts of less mowing could make this strategy doable. Scaling back by a single mowing cycle generates savings of nearly \$4 million per year — cutting roughly 1/3 off the original 2020 projections.

Table 4.2 2020 Contracted Mowing Expenses

	Price Per Acre	Number of Cycles	Total Acreage	Total Expense
District 1	\$79.32	14	13,861.00	\$1,099,484.30
District 2	\$51.06	18	22,156.50	\$1,131,375.00
District 3	\$63.29	30	26,742.12	\$1,692,638.15
District 4	\$51.56	33	23,503.08	\$1,211,932.14
District 5	\$53.63	21	13,116.00	\$703,396.80
District 6	\$53.48	24	12,187.80	\$651,753.43
District 7	\$45.77	38	22,168.00	\$1,014,626.50
District 8	\$51.61	15	10,545.00	\$544,267.50
District 9	\$32.19	6	9,597.00	\$308,896.80
District 10	\$76.40	3	2,959.80	\$226,128.72
District 12	\$62.30	18	7,662.00	\$477,308.10
Interstates	\$43.28	63	73,074.40	\$3,162,575.68
Totals	\$51.46	283	237,572.70	\$12,224,383.12

Table 4.3 Anticipated 2020 Mowing Expenses (One Type 2 Cycle)

	# Type 2 Cycles	Acres Per Type 2 Cycle	# Type 3 Cycles	Acres Per Type 3 Cycle	Total Expense
District 1	3	2,932.60	11	6,331.00	\$900,027.80
District 2	6	4,556.71	12	7,385.50	\$982,819.00
District 3	9	2,564.95	21	8,914.04	\$1,396,596.47
District 4	10	1,941.19	23	7,834.36	\$923,804.59
District 5	6	1,440.35	15	4,372.00	\$567,528.20
District 6	4	530.08	20	4,062.60	\$560,756.40
District 7	9	2,363.47	29	6,264.00	\$873,683.51
District 8	3	1,020.41	12	3,515.00	\$489,507.31
District 9	2	2,417.76	4	3,199.00	\$283,593.81
District 10	0	0.00	3	986.60	\$226,128.72
District 12	2	654.11	16	2,554.00	\$453,114.95
Interstates	16	15,098.29	47	22,177.68	\$2,910,592.00
Totals	70	35,519.93	213	77,595.78	\$10,568,152.76

Table 4.4 Projected Mowing Expenses (Elimination of One Type 3 Cycle)

	Price Per Acre	Number of Cycles	Total Acreage	Total Expense
District 1	\$78.74	9	7,530	\$592,922.15
District 2	\$51.06	12	14,771	\$754,250.00
District 3	\$63.29	20	17,828	\$1,128,425.43
District 4	\$51.56	22	15,669	\$807,954.76
District 5	\$53.63	14	8,744	\$468,931.20
District 6	\$53.48	16	8,125	\$434,502.29
District 7	\$45.85	28	15,904	\$729,271.40
District 8	\$51.61	10	7,030	\$362,845.00
District 9	\$32.19	6	9,597	\$308,896.80
District 10	\$76.40	2	1,973	\$150,752.48
District 12	\$62.30	12	5,108	\$318,205.40
Interstates	\$43.60	45	50,897	\$2,219,097.44
Totals	\$50.72	196	163,176	\$8,276,054.35

Lastly, we look at how much the agency stands to save over the next few years by mowing less. Table 4.5 lays out these projections. Our calculations assume an annual inflation rate of 2.0%. While inflation forecasts vary, this is a reasonable figure to use for year-over-year cost increases. Yearly savings and a running total of cumulative savings are presented for two scenarios. Scenario 1 mirrors what KYTC has done in 2020 — switching one Type 3 cycle to a Type 2 cycle and keeping the remaining cycles as Type 3. Scenario 2 eliminates one Type 3 mowing cycle per year. Annual savings resemble those presented above — under Scenario 1, the Cabinet could expect to see \$1.6 million in savings; this climbs to just shy of \$4 million for Scenario 2. Over the five-year period, irrespective of the Scenario chosen, KYTC would accrue significant savings. Under Scenario 1, total savings are roughly \$9.5 million, while Scenario 2 yields upwards of \$24 million. It is important to keep in mind that these estimates only account for mowing-related expenses. As highlighted in the summary of agency practices, reducing mowing frequencies will require at least a temporary increase in herbicide applications to keep unwanted species at bay. Assuming herbicide applications would increase, expected savings will be lower than indicated in Table 5. Nonetheless, the Cabinet would likely see a large drop in how much it is paying contractors to mow along roadsides.

Table 4.5 Mowing Costs and Cumulative Savings for Different Mowing Scenarios (2020-2025)

	Baseline Scenario	Scenario 1	Scenario 1 Cumulative Savings	Scenario 2	Scenario 2 Cumulative Savings
2020	\$12,224,383.12	\$10,568,152.76	\$1,656,230.36	\$8,276,054.35	\$3,948,328.77
2021	\$12,407,748.87	\$10,779,515.82	\$3,284,463.41	\$8,441,575.44	\$7,914,502.20
2022	\$12,593,865.10	\$10,995,106.13	\$4,883,222.38	\$8,610,406.95	\$11,897,960.35
2023	\$12,782,773.08	\$11,215,008.25	\$6,450,987.20	\$8,782,615.08	\$15,898,118.35
2024	\$12,974,514.67	\$11,439,308.42	\$7,986,193.46	\$8,958,267.39	\$19,914,365.63
2025	\$13,169,132.39	\$11,668,094.59	\$9,487,231.26	\$9,137,432.73	\$23,946,065.29

4.2 Current and Projected Litter Removal Expenditures

Throughout Kentucky, 174 litter cycles have been slated for 2020, which represents a modest increase over the 152 litter cycles in 2019 (Table 4.6). While KYTC spends less on litter removal than mowing, the expense is nonetheless considerable — the agency spent \$3.7 million in 2019 and is contracted to spend over \$4 million in 2020. The unit

cost of litter removal varies dramatically between districts, ranging from \$120 per mile in Franklin County to nearly \$300 per mile along interstate routes.

Table 4.6 2019 and 2020 Litter Removal Expenditures

	2019			
	Cost Per Mile	Number of Miles	# Litter Cycles	Total Expense
District 1	\$250.00	12.0	5	\$15,000.00
District 2	\$226.03	106.4	9	\$72,150.00
District 5	\$120.00	173.4	5	\$104,040.00
District 6	\$180.00	514.5	9	\$277,830.00
District 7	\$243.93	145.7	13	\$210,117.40
District 9	\$190.12	318.6	10	\$302,883.75
District 12	\$270.00	110.9	5	\$149,715.00
Interstates	\$288.53	1749.5	96	\$2,609,185.55
Totals	•	3131.0	152	\$3,740,921.70
	2020			
	Cost Per Mile	Number of Miles	# Litter Cycles	Total Expense
District 1	\$250.00	12.0	5	\$15,000.00
District 2	\$296.96	133.4	9	\$118,843.50
District 5	\$120.00	173.4	5	\$104,040.00
District 6	\$180.00	480.6	9	\$259,524.00
District 7	\$243.93	145.7	13	\$210,117.40
District 9	\$178.92	318.6	10	\$285,051.00
District 12	\$284.93	293.4	10	\$417,990.00
Interstates	\$291.03	1738.0	113	\$2,644,775.40
Totals	•	3295.1	174	\$4,055,341.30

As with mowing expenses, we developed projections for how much the Cabinet will spend on litter removal through 2025 (Table 4.7). The baseline scenario assumes no change in the number of litter removal cycles and an annual price increase of 2.0% (again, to account for inflation). Under Scenario A, all contracts would be modified to eliminate one litter removal cycle — this would result in a total of 137 cycles across Kentucky. Yearly savings are approximately \$817,000, with total savings over the five-year period amounting to \$5.15 million. This is admittedly a coarse-grained forecast and assumes, as with our mowing forecasts, uniform changes in all contracts. KYTC Central Office staff will likely need to consult with district personnel to identify whether any routes would be irreparably harmed by the loss of a litter removal cycle. It is critical to rely on the context-sensitive knowledge that district personnel have when developing new strategies for litter removal (and mowing). A top-down directive which does not properly account for local contingencies could ultimately prove detrimental.

Table 4.7 Litter Removal Costs and Cumulative Savings for a One-Cycle Reduction (2020-2025)

	Baseline Scenario	Scenario A (One Less Cycle)	Scenario 1 Cumulative Savings
2020	\$4,055,341.30	\$3,237,506.85	\$817,834.45
2021	\$4,136,448.13	\$3,302,256.99	\$1,652,025.59
2022	\$4,219,177.09	\$3,368,302.13	\$2,502,900.55

2023	\$4,303,560.63	\$3,435,668.17	\$3,370,793.01
2024	\$4,389,631.84	\$3,504,381.53	\$4,256,043.32
2025	\$4,477,424.48	\$3,574,469.16	\$5,158,998.64

4.3 Conclusions and Considerations

Mowing less and removing litter less frequently can potentially yield appreciable savings over the 2020-2025 period. For example, combining Scenario 1 for mowing with Scenario A for litter removal could net KYTC roughly \$14.2 million in savings. Opting instead for Scenario 2 for mowing along with Scenario A for litter removal could yield over \$29 million in savings. As noted, these projections are idealized, and the Cabinet could potentially adjust mowing and litter removal practices throughout the state in a manner which accounts for local conditions (i.e., avoid using a one-size-fits-all strategy). For example, in some areas it may be reasonable to skip one mowing cycle entirely without repercussions, whereas in other places this regimen could be unsustainable, with at least early-season Type 2 mowing being essential. Another consideration is that these estimates do not account for changes in herbicide applications. Most agencies which have shifted toward conservation mowing have needed to up herbicide applications (at least initially). Some of the savings accrued by mowing will likely need to go toward herbicides to ensure undesirable species are kept in check. Before making any changes, it is critical to discuss potential options with Roadside Environmental District Administrators (REDAs). They have the deepest knowledge and expertise of the areas they oversee and are in the best position to determine what adjustments could be made to mowing and litter removal strategies and the extent to which savings from mowing reductions may be offset by increased herbicide use. Another potential issue to work through is contract administration. Increasing the variability and complexity of contracts could impose more demands on KYTC staff.

With the Cabinet having shifted to a Type 2 mowing cycle for the first mowing cycle in 2020, Central Office staff will benefit from soliciting feedback from REDAs to understand what problems, if any, resulted from the conversion of a Type 3 cycle to a Type 2 cycle (e.g., challenges with mowing taller vegetation, equipment damage, longer mowing times, difficulty identifying and removing litter). Ideally, these conversations should occur toward the end of this season but prior to the establishment of a mowing plan for the 2021 season — and is something KTC researchers can assist with.

Chapter 5 KYTC's Proposed 2020 Plan for Reduced Roadside Mowing

In October 2019, KYTC's Central Office Division of Maintenance circulated among Roadside Environmental District Administrators (REDAs) a proposed conservation mowing plan. This plan is reproduced in its entirety on the next page. It is broadly consistent with mowing practices introduced by other state DOTs as well as the best practices outlined in Chapter 3. As described in Chapter 4, in 2020 budget shortfalls anticipated from the fallout of COVID-19 motivated the adoption of a plan whereby the year's first mowing cycle was converted to a Type 2 cycle. Subsequent cycles were Type 3. Nonetheless, briefly reviewing the proposed 2020 plan is useful for pinpointing where KYTC's strategies diverge from best practices catalogued in Chapter 3. Specifically, we highlight three areas in which the plan from practices commonly used by other agencies — in its treatment of medians, fence-line mowing, and herbicide use. We recognize, however that the proposed 2020 plan only addresses mowing explicitly — not the use of chemicals. Nonetheless, we think it is worth mentioning this issue. In pointing out these divergences, our purpose is not to suggest the Cabinet's strategies are deficient. Best practices described in Chapter 3 should not be interpreted as a one-size-fits-all straitjacket all agencies should adhere to. Rather, we hope to underscore challenges the Cabinet may want to remain attentive to going forward.

Medians

During each mowing cycle, the 2020 strategy calls for mowing the entirety of normal width medians on interstates, parkways, selected priority routes, and rural two-lane roadways. One modification the Cabinet may want to consider is mowing just once per year median interiors which exceed a threshold width. Several agencies that have adopted this practice. Those which do have established threshold widths between 40 and 70 feet. That is, if the entire median exceeds this width, strip mowing is done along the 15 feet adjacent to the roadway, while areas within the strips are only mowed once per year. Most commonly, this strategy is used on interstates, freeways, and other access-controlled routes (as medians are most likely to exceed threshold widths on these roadway types).

Herbicide Applications

Many agencies have noted the importance of using selective herbicide treatments in areas that are mowed less often to minimize the encroachment of undesirable or invasive vegetation. Some DOTs also use plant growth regulators or selective herbicides applications in areas where strip mowing has been adopted. By reducing vegetation growth, the latter strategy can keep grass heights suppressed and preclude the need for mid-cycle mowing.

Fence-Line Mowing

The 2020 strategy directs staff to mow the entire state-owned right of way during the fall cleanup mowing. At least a few agencies have experimented with mowing out to the fence line every few years or rely on selective herbicides and spot mowing. Performing a full clear-out of roadside vegetation at 2-3-year intervals is an option KYTC could look at. However, experimentation with this practice should initially be limited to a few trial locations, because it is important to determine how vegetation will react to less frequent mowing and evaluate whether mowing every 2-3 produces hazardous conditions that mowing personnel will have trouble navigating. It is likely this practice will also need to be paired with selective herbicide use to keep undesirable vegetation in check (something the Illinois DOT currently does).

The points brought up above are minor, and we stress that the Cabinet needs to implement a mowing program which balances environmental and economic considerations. The fact that one or several agencies have instituted a practice does not mean KYTC must do likewise. Indeed, ultimately the purpose of this project was to give KYTC staff insights into strategies other agencies have found beneficial for enhancing pollinator habitat while saving money through reduced mowing. Whatever plan the Cabinet decides upon should be attuned to the contingencies of Kentucky's landscape (which can vary between or even within individual districts). Pursuing adaptive management — where mowing plans are revised on a regular basis in light of documented performance trends — will be critical for transforming the state's roadside landscapes into more pollinator-friendly spaces.

2020 Mowing Strategies – Monarch Butterfly/Pollinator Habitat Enhancement

❖ **Derby Mowing Cycle (late April – early May):**

- Mow one pass (15 feet) on the outside shoulder of the selected interstate routes;
- Mow one pass (15 feet) on the inside shoulder of bifurcated sections of these routes;
- Mow one pass (15 feet) on the left and right shoulders of intersection ramps;
- Mow the entire area of normal width medians where a median exists;
- Mowing Height: 6-8 inches;
- Trim all appurtenances located within the mowed areas;
- Pickup and remove litter from fence-line to fence-line on these selected routes.

❖ **Right-of-Way Mowing – Interstate, Parkway, and Various Selected Priority Routes:**

- Mow one pass on the outside shoulder of the selected interstate routes;
- Mow one pass on the inside shoulder of bifurcated sections of these routes;
- Mow one pass on the left and right shoulders of intersection ramps;
- Mow the entire area of normal width medians where a median exists;
- Mowing Height: 8-10 inches;
- Trim all appurtenances located within the rights-of-way on all projects that have trimming as a work item;
- Mowing Frequency: Two Cycles;
- Mowing Dates: May 10 – June 15 and July 10 – August 15 (Note: this 2nd cycle will be eliminated after the 2020 mowing season and will only be performed on an as needed basis at selected locations);
- Pickup and remove litter from fence-line to fence-line on these selected routes on all projects that have litter removal as a work item.

❖ **Fall Clean-up Mowing – Interstate, Parkway, and Various Selected Routes:**

- Mow the entire right-of-way to the designated boundary line, which will be established during the mowing season;
- Mowing Height: 8-12 inches;
- Trim all appurtenances located within the rights-of-way that have trimming as a work item;
- Mowing Dates: October 15 – December 1
- Pickup and remove litter from fence-line to fence-line on these selected routes that have litter removal as a work item

❖ **Right-of-Way Mowing – Rural Two-Lane Routes:**

- Mow the shoulder and backslope areas of all rural routes to a maximum of twenty (20) feet from the designated pavement edge line (Mowing on areas that are beyond the maximum twenty-foot limit will be mowed during the Fall Cleanup Mowing Cycle);
- Mow the entire area of normal width medians where a median exists;
- Mowing Height: 8-10 inches;
- Trim all appurtenances located within the rights-of-way on all projects that have trimming as a work item;
- Mowing Frequency: Three Cycles;
- Mowing Dates: May 10 – June 15, July 10 – August 15, and October 15 – December 1;
- Pickup and remove litter from fence-line to fence-line on all projects that have litter removal as a work item.

❖ **Fall Clean-up Mowing – Rural Two-Lane Routes:**

- Mow the entire right-of-way to the designated right-of-way line;
- Mowing Height: 8-12 inches;
- Trim all appurtenances located within the rights-of-way that have trimming as a work item;
- Mowing Dates: October 15 – December 1
- Pickup and remove litter from fence-line to fence-line on all projects that have litter removal as a work item.

Figure 5.1 Proposed 2020 Mowing Strategies

Chapter 6 KYTC’s 2021 Mowing Program

In November 2020, the Cabinet’s State Highway Engineer (SHE) approved a mowing plan for calendar year 2021 that aims to enhance pollinator habitat. While the plan may result in cost savings and improved roadside aesthetics, these are not the primary goals. Table 6.1 summarizes mowing strategies by route type. Figure 6.1 presents the plan in full. The main idea behind the plan is to let pollinator habitat positioned between the edge of mown areas and the ROW fence to grow undisturbed during the spring and early summer along rural interstates, parkways, and other selected routes. KYTC — consistent with practices adopted by other agencies — is not prioritizing interstates and high-volume routes for pollinator habitat. Rural routes typically lack significant vegetation beyond the 10-foot mown strip, making them less-than-ideal candidates for mowing reductions.

Table 6.1 Key Features of KYTC's 2021 Mowing Plan

Route Type	Number of Mowing Cycles	Cycle Types
Urban Interstate and Selected Priority Routes	4-5	<ul style="list-style-type: none"> • All Type 3
Rural Interstate, Parkways, Other Selected Routes	3	<ul style="list-style-type: none"> • First Cycle — Type 2 • Remaining Cycles — Type 3
Rural Routes	2-3	<ul style="list-style-type: none"> • All Type 3

2021 Mowing Strategies – Monarch Butterfly/Pollinator Habitat Enhancement/Safety

- ❖ **Urban Interstate and Selected Priority Routes, such as New Circle Road (KY 4):**
 - Projects will have 4-5 full mowing cycles (Type 3) with an option of adding a cycle if the District feels there is a need and they have the funds;
 - This will include the medians, interchange quadrants, ramps, and gore areas;
 - Trimming and litter removal are also included;
 - The mowing height will be 6-10 inches;
 - We are not considering these urban route projects for pollinator habitat.

- ❖ **Rural Interstate, Parkway, and Other Selected Routes, such as I-64 West (Lexington to Louisville):**
 - Projects will have three (3) cycles with specified start dates for each cycle:
 - The first cycle will be a reduced mowing cycle (Type 2);
 - This will include one swath on the outside shoulder on the mainline, one swath on the left and right shoulders of the ramps, one swath on the left shoulder of bi-furcated median sections, and the full width of standard medians;
 - This will also include trimming and litter removal;
 - Interchange quadrants will not be mowed on this cycle;
 - This will allow pollinator habitat vegetation that is growing between the mowed areas and the R/W fence to grow undisturbed.
 - This is also true for the bi-furcated median areas and the interchange quadrants;
 - The mowing height will be 6-10 inches;
 - This mowing cycle will begin in mid to late May and be completed by mid-June;
 - The second cycle will be a full mowing cycle (Type 3)
 - This will include the roadsides to the fence or other barrier, all interchange quadrants, all full width medians, trimming, and litter removal;
 - The mowing height will be 6-10 inches;
 - This mowing cycle will begin in early July and be completed in mid-late August;
 - This mowing will remove the top growth on pollinator habitat plant species and allow them to regenerate as succulent plants for the pollinators, especially for the Monarch Butterfly;
 - The third cycle will also be a full mowing cycle (Type 3)
 - This will include all the same areas as the 2nd cycle;
 - This mowing cycle will begin in mid-late October and be completed by mid-late November;
 - The mowing height will be 6-10 inches;
 - This mowing will be considered as a clean-up mowing and will reduce the incidence of any small woody species and other undesirable plants that are prevalent in the mowing areas;
 - This will help the pollinator plant species to become better established on these roadsides and better able to perform as desirable habitat for the following spring;

- ❖ **Rural Routes, such as US 421 (Lexington to Midway to Frankfort):**
 - Projects will have three (3) full cycles (Type 3) with the first cycle beginning in late May;
 - The mowing height will be 6-10 inches;
 - Trimming and Litter Removal will be performed on those county or route projects that have them as a work item;
 - We are not considering these projects as viable pollinator habitat areas, as most of these routes have little or no vegetation beyond 10-15 feet.

Figure 6.1 KYTC 2021 Mowing Plan

❖ **Rural Routes, such as all two-lane routes in Franklin County:**

- Projects will have two (3) full cycles (Type 3) with the first cycle beginning in mid-late July;
- The district will be applying a Plant Growth Regulator (PGR) to the roadside turf in early May to prevent the growth of seed heads on the grass, in lieu of an mowing cycle;
- However, they will have the option to add a mowing cycle if the weather does not allow the district to get the PGR materials applied or if their efforts are unsuccessful;
- The mowing height will be 6-10 inches;
- Trimming and Litter Removal will be performed on those county or route projects that have them as a work item;
- We are not considering these projects as viable pollinator habitat areas, as most of these routes have little or no vegetation beyond 10-15 feet.

Figure 6.1 KYTC 2021 Mowing Plan

Chapter 7 *Kentucky's Buzzing!* Marketing Campaign

Many of the agency personnel we spoke with affirmed the importance of being transparent about changes in mowing and landscape management practices. Leveraging DOT websites, advertising, social media, and other venues to talk with the public about how policies are changing and how the appearance of roadside landscapes will be transformed as new management practices are brought online is essential. Doing so may not eliminate phone calls and messages inquiring or complaining about grass and vegetation that appears overgrown. However, having resources available that people can be directed to which explain the intent of landscape management practices can alleviate the burdens placed on maintenance personnel, customer service representatives, and other frontline staff. For this project, we were not asked to conceptualize a full marketing campaign for a KYTC conservation mowing program. The Study Advisory Committee asked us to develop a one-page document which explains changes in mowing practices, why pollinators are critical species, and the amount of time it will take to see results. This document could potentially form the basis of a more wide-ranging marketing effort. We have designated the campaign *Kentucky's Buzzing!* and developed a logo that could be used in future materials and press releases. A full reproduction of the document can be found on the next page. While this provides a starting point, it will be critical to prepare a fully coordinated statewide initiative that ensures consistent messaging across districts.



Kentucky's Buzzing! — Vegetation Management to Transform Kentucky's Roadside Landscapes

What's Happening on Kentucky's Roadsides?

Drivers are used to seeing neatly trimmed grass extending from the roadway edge to the border of state-maintained property. Beginning this year motorists will encounter a new look on rural interstates, parkways, and some other routes. Mowing will be done less often and focus on a 15-foot strip adjacent to the shoulder. Less frequent mowing will encourage the growth of pollinator habitat and foster the growth of native plants, including colorful wildflowers. Although the vegetation will be a little taller in some areas, this will not impact driver visibility or safety.



How Long Will It Take to See Results?

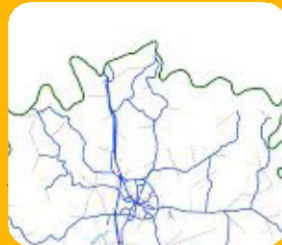
Based on the experiences of other state departments of transportation that have introduced programs to expand pollinator habitat, wildflowers and native vegetation will not return immediately. It is a gradual process and will require adjusting management strategies over multiple growing seasons. During this period, KYTC's will focus on promoting native vegetation and suppressing invasive species. The transformation of Kentucky's roadsides will progressively unfold over the next 5 to 10 years.



KYTC's Efforts to Expand Pollinator Habitat

In addition to mowing less, the Cabinet is rapidly increasing the number of pollinator habitats it maintains around the state. Fifty-five new pollinator plots will be completed by fall of 2021, bringing the number KYTC-managed plots to 125. The new plots will add 135 acres of pollinator habitat and increase the total number of pollinator habitat acres overseen by the Cabinet to 230. Over the next few years, KYTC aims to grow total pollinator habitat acreage by 50% each year.

What Are Pollinators and Why Are They Important?



Most plants could not reproduce without the help of pollinators. Pollinators move pollen from one flower to another, which results in the production of seeds and fruit. Pollinators help pollinate at least 180,000 plant species and over 1,200 crops — including many of the crops we rely on for food. While estimates vary, the market value of crops pollinated by insects is around \$30 billion each year. A commonly cited statistic is that in 3 bites of food we take is directly attributable to pollinators! Key pollinators include bees, butterflies, moths, bats, birds, ants, flies, and beetles.

Are There Other Benefits?



Increasing plant diversity in roadside landscapes creates a more varied appearance, which can improve driver safety. Studies have found roadsides with colorful wildflowers and vegetation growing to different heights increases driver alertness and may reduce crashes. Also, less mowing can reduce deer-vehicle collisions by lessening the abundance of freshly cut grass — a food source which deer prefer.



The Kentucky Transportation Cabinet • 200 Mero Street, Frankfort KY • 502-564-4890 • www.transportation.ky.gov



Figure 7.1 Marketing One-Pager for Kentucky's Buzzing!

Resources and References

Research for this project has entailed looking at policies, guidance manuals, press releases, other research reports, presentations by agency staff, and agency websites. Consequently, a traditional bibliography may not be of the most help to readers wanting to track down the materials used to prepare the synthesis of state practices. As such, this section lists published materials that were consulted during research and provides a direct link to these documents. All documents are located in a Dropbox folder. Clicking on a document will open up the Dropbox page and give users the opportunity to download it.

Alabama

Alabama Department of Transportation. 2018. [A Manual for Roadside Vegetation Management](#).

Florida

Ferrell, J., Unruh, B., Kruse, J. 2012. [A Guide for Roadside Vegetation Management](#).

Florida Department of Transportation. 2016. [Formulating and Implementing a Planting Plan — Establishing New Plantings from Seed](#).

Florida Department of Transportation. 2016. [Wildflower Program](#).

Harrison, G.L. 2014. [Economic Impact of Ecosystem Services Provided by Ecologically Sustainable Roadside Right of Way Vegetation Management Practices](#). Tallahassee, FL: Florida Department of Transportation.

Norcini, J.G. 2014. [Madison County Energy Conservation Study: 2012-2013 Survey of Roadside Vegetation](#).

Tallahassee, FL: Florida Department of Transportation.

Indiana

Indiana Department of Transportation. 2014. [INDOT Mowing and Vegetation Management Policy Takes Root](#).

Indiana Department of Transportation. 2014. [Vegetation Management Policy](#).

Indiana Department of Transportation. 2019. [Contract Information Book — Herbicide Treatment](#).

Indiana Department of Transportation. 2019. [Contract Information Book — Mowing](#).

Indiana Department of Transportation. 2019. [Mowing and Vegetation Management Policy](#).

Illinois

Illinois Department of Transportation. 2018. [Operation Habitat Presentation](#).

Illinois Monarch Project. 2019. [Mowing Guidelines for Pollinators](#).

Illinois Department of Transportation. n.d. [Strategically Applied Vegetation Exemption Mowing Presentation](#).

Maryland

Kuder, L. 2019. [Evaluating Integrated Roadside Vegetation Management \(IRVM\) Techniques to Improve Pollinator Habitat](#). Baltimore, MD: Maryland Department of Transportation.

Maryland State Highway Administration. 2003. [Integrated Vegetation Management Manual for Maryland Highways](#).

Maryland State Highway Administration. 2016. [Maryland State Highway Administration Landscape Design Guide](#).

Maryland State Highway Administration. 2017. [Design and Estimating Principles for Category 700 — Landscaping](#).

Maryland State Highway Administration. n.d. [MDOT SHA Pollinator Habitat Plan](#).

Minnesota

Minnesota Department of Agriculture. n.d. [Pollinator Best Management Practices for Roadsides and Other Rights-of-Way](#).

Minnesota Department of Transportation. 2016. [Debris and Roadsides](#). In *MnDOT Maintenance Manual*.

Minnesota Department of Transportation. 2016. [Memorandum of Understanding: Agreement for the Support of a Monarch Highway](#).

Minnesota Department of Transportation. 2016. [Partnerships for Promoting Pollinator Habitat](#).

Minnesota Department of Transportation. 2017. [MnDOT District 4 Integrated Roadside Vegetation Management Plan](#).

Minnesota Department of Transportation. n.d. [Mowing Smart: A Cost Saving and Eco Friendly Policy](#).

Missouri

Missouri Department of Transportation. 2003. [Roadside Vegetation Management](#).

Missouri Department of Transportation. 2017. [Roadside Vegetation Management](#). (Updated Edition).

Nebraska

Nebraska Department of Transportation. 2020. [NDOT Roadside Vegetation Establishment and Management](#).

Wu-Smart, J., Schacht, W. 2019. [Establishment of Wildflower Islands to Enhance Roadside Health and Aesthetics](#). Lincoln, NE: Nebraska Department of Transportation.

Ohio

Ohio Department of Transportation. 2016. [Statewide Roadside Pollinator Habitat Program Restoration Guidelines and Best Management Practices](#).

Ohio Department of Transportation. 2017. [ODOT Guide to Establishing and Maintaining Roadside Pollinator Habitats](#).

Ohio Department of Transportation. 2019. [Guidelines for Mowing Reduction Outside Clear Zones for Compliance with the Candidate Conservation Agreement with Assurances \(CCAA\) for the Monarch Butterfly](#).

Ohio Department of Transportation. 2019. [Pollinator Habitats in Rights of Way](#). Presentation to the Ohio Transportation Engineering Conference.

Ohio Department of Transportation. 2019. [ODOT Pollinator Habitat Program Update](#). Presentation to the OPHI 2019 Pollinator Symposium.

Pennsylvania

Pennsylvania Department of Transportation. 2019. [Roadside Beautification Manual](#).

Pennsylvania Department of Transportation. 2019. [Roadside Management](#). In *Pennsylvania Department of Transportation Maintenance Manual*.

Pennsylvania Department of Transportation. 2019. [PennDOT Pollinator Habitat Establishment Job Sheet](#).

Pennsylvania Department of Transportation. 2019. [Voluntary Prelisting Pollinator Conservation Program](#).

Pennsylvania State University. 2018. [Pennsylvania Pollinator Protection Plan](#).

Tennessee

Tennessee Department of Transportation. 2015. [Special Provision Regarding Removal and Disposal of Litter](#).

Tennessee Department of Transportation. 2015. [Special Provision Regarding Rights-of-Way Mowing](#).

Tennessee Department of Transportation. 2016. [TDOT Integrated Vegetation Management Program Guidelines](#).

Tennessee Department of Transportation. 2017. [Tennessee Department of Transportation Division of Maintenance Standard Operating Guideline \(SOG 435-1\) — Mowing](#).

Tennessee Department of Transportation. 2017. [Tennessee Department of Transportation Division of Maintenance Standard Operating Guideline \(SOG 436-1\) — Slope Mowing](#).

Tennessee Department of Transportation. 2019. [Special Notes Regarding Right of Way Mowing and Litter Removal](#).

Tennessee Department of Transportation. n.d. [Things to Know About Our Pollinator Project](#).

Texas

Texas Department of Transportation. 2018. [Roadside Vegetation Management Manual](#).

Virginia

Virginia Department of Transportation. 2010. [VDOT Vegetation Management Policy](#).

Virginia Department of Transportation. 2016. [Maintenance Best Practices Manual](#).

Virginia Department of Transportation. n.d. [VDOT's Pollinator Habitat Program](#).

Washington

Washington Department of Transportation. 2016. [Promoting the Health of Pollinators along WSDOT's Roadsides](#).

Washington Department of Transportation. 2017. [Roadside Manual](#).
Washington Department of Transportation. 2019. [Maintenance Manual](#).
Washington Department of Transportation. 2019. [Olympic Region Integrated Roadside Vegetation Management Plan](#).
Washington Department of Transportation. 2019. [Southwest Region Integrated Roadside Vegetation Management Plan](#).
Washington Department of Transportation. n.d. [Creation of Pollinator Habitat](#).
Willard, R. 2020. [Practical Solutions for Roadside Land Use](#). Transportation Research Board Annual Meeting.

Wisconsin

Wisconsin Department of Agriculture, Trade and Consumer Protection. n.d. [Wisconsin Pollinator Protection Plan](#).
Wisconsin Department of Transportation. 2015. [Managing Prairie Remnants and Native Seeding](#). In *Highway Maintenance Manual*.
Wisconsin Department of Transportation. 2015. [Rural Mowing](#). In *Highway Maintenance Manual*.
Wisconsin Department of Transportation. 2015. [Urban Mowing](#). In *Highway Maintenance Manual*.
Wisconsin Statutes and Annotations. [Invasive Species Identification, Classification and Control](#). Chapter NR 40.
Wisconsin Statutes and Annotations. [Roadside Vegetation Management](#). Chapter Trans 280.

Other Resources (Not Linked)

Cariveau, A. B., W. Caldwell, E. Lonsdorf, C. Nootenboom, K. Tuerk, E. Snell-Rood, E. Anderson, K. A. Baum, J. Hopwood, and K. Oberhauser. 2020. [Evaluating the Suitability of Roadway Corridors for Use by Monarch Butterflies](#). NCHRP Research Report 942. Transportation Research Board, Washington, D.C.

Entsminger, E.D., Jones, J.C., Guyton, J.W., Leopold, B.D., Strickland, B.K. 2019 Mowing effects on woody stem density and woody and herbaceous vegetation heights along Mississippi highway rights-of-way. *Journal of Fish and Wildlife Management*, 10(1), 19-37.

Federal Highway Administration (FHWA). 2015. *Literature Review: Pollinator Habitat Enhancement and Best Management Practices in Highway Rights-of-Way*. Federal Highway Administration, Washington, D.C.

Federal Highway Administration (FHWA). 2016. *Pollinators and Roadsides: Best Management Practices for Managers and Decision Makers*. Federal Highway Administration, Washington, D.C.

Galea, M., Wojcik, V., Adams, L.D., Cole, E. 2016. Maintaining Roadsides for Pollinators Establishment, Restoration, Management and Maintenance. Pollinator Partnership, San Francisco, California.

Gardiner, M. M., Riley, C. B., Bommarco, R., Öckinger, E. (2018). Rights-of-way: a potential conservation resource. *Frontiers in Ecology and the Environment*, 16(3), 149-158.

Hopwood, J. L. (2008). The contribution of roadside grassland restorations to native bee conservation. *Biological conservation*, 141(10), 2632-2640.

Hopwood, J., Black, S., Fleury, S. 2015. *Roadside Best Management Practices that Benefit Pollinators: Handbook for Supporting Pollinators through Roadside Maintenance and Landscape Design* (Report No. FHWA-HEP-16-059). Federal Highway Administration, Washington, D.C.

Jakobsson, S., Bernes, C., Bullock, J. M., Verheyen, K., & Lindborg, R. (2018). How does roadside vegetation management affect the diversity of vascular plants and invertebrates? A systematic review. *Environmental Evidence*, 7(1), 17.

Natural Resources Conservation Service (NRCS). 2016. *Kentucky Pollinator Handbook*. U.S. Department of Agriculture.

Noordijk, J., Delille, K., Schaffers, A. P., Sýkora, K. V. (2009). Optimizing grassland management for flower-visiting insects in roadside verges. *Biological Conservation*, 142(10), 2097-2103.

Thogmartin, W.E., López-Hoffman, L., Rohweder, J., Diffendorfer, J., Drum, R., Semmens, D., Black, S., Caldwell, I., Cotter, D., Drobney, P., Jackson, L.L. 2017 Restoring Monarch Butterfly habitat in the Midwestern US: 'All hands on deck'. *Environmental Research Letters*. 12(7):074005.

Valtonen, A. K. S. J. J., Saarinen, K., Jantunen, J. (2006). Effect of different mowing regimes on butterflies and diurnal moths on road verges. *Animal Biodiversity and Conservation*, 29(2), 133-148.

Wojcik, V. A., Buchmann, S. (2012). Pollinator conservation and management on electrical transmission and roadside rights-of-way: a review. *Journal of Pollination Ecology*, 7.