Pollinator Habitat Along Highway Right of Way

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16. Abstract

Pollinators are important components of our ecosystems, as well as being important contributors to agricultural production. Highway right of way (ROW) is one potential habitat for pollinators. The objectives of this study were to assess existing practices of other agencies for promoting pollinator habitat within the ROW and to identify potential locations for pollinator habitat in Missouri. The study methodology included a review of academic and practitioner literature, survey of state departments of transportation (DOTs), DOT interviews, and geographic information system (GIS) analysis. The literature review found that various practitioner resources are available regarding site assessment, best management practices (BMPs), planting guidance, and other topics related to promoting pollinator habitat within the ROW. The literature addresses the suitability of a particular site for pollinator habitat based on various factors such as cover and health of existing vegetation, mowing frequency, soil texture and pH, land use, site size, sunlight, water availability, and accessibility. Survey results indicated that the most frequently utilized methods for promoting pollinator habitat in the highway ROW are planting native species that benefit pollinators, limiting the frequency of mowing, and vegetation management practices. DOTs perceive the designation of right of way on DOT facilities and reclassification of existing habitat as the most effective methods for promoting pollinator habitat. GIS was used to analyze multiple data layers (including ROWs, public lands and bodies of water, and land use/land cover) to quantify potential available land for pollinator habitat development and connectivity with other natural landscapes. A 500' buffer around the ROW parcels was used to identify potential intersections with parks, natural areas and bodies of water. GIS files transmitted with this report will allow MoDOT to examine the locations of upcoming projects to identify those warranting further consideration as pollinator habitat.

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ABSTRACT

Pollinators are important components of our ecosystems, as well as being important contributors to agricultural production. Highway right of way (ROW) is one potential habitat for pollinators. The objectives of this study were to assess existing practices of other agencies for promoting pollinator habitat within the ROW and to identify potential locations for pollinator habitat in Missouri. The study methodology included a review of academic and practitioner literature, survey of state departments of transportation (DOTs), DOT interviews, and geographic information system (GIS) analysis. The literature review found that various practitioner resources are available regarding site assessment, best management practices (BMPs), planting guidance, and other topics related to promoting pollinator habitat within the ROW. The literature addresses the suitability of a particular site for pollinator habitat based on various factors such as cover and health of existing vegetation, mowing frequency, soil texture and pH, land use, site size, sunlight, water availability, and accessibility. Survey results indicated that the most frequently utilized methods for promoting pollinator habitat in the highway ROW are planting native species that benefit pollinators, limiting the frequency of mowing, and vegetation management practices. DOTs perceive the designation of right of way on DOT facilities and reclassification of existing habitat as the most effective methods for promoting pollinator habitat. GIS was used to analyze multiple data layers (including ROWs, public lands and bodies of water, and land use/land cover) to quantify potential available land for pollinator habitat development and connectivity with other natural landscapes. A 500’ buffer around the ROW parcels was used to identify potential intersections with parks, natural areas and bodies of water. GIS files transmitted with this report will allow MoDOT to examine the locations of upcoming projects to identify those warranting further consideration as pollinator habitat.

EXECUTIVE SUMMARY

Pollinators are important components of our ecosystems, as well as being important contributors to agricultural production. Highway right of way (ROW) is one potential habitat for pollinators. The objectives of this study were to assess existing practices of other agencies for promoting pollinator habitat within the ROW and to identify potential locations for pollinator habitat in Missouri. The study methodology included a review of academic and practitioner literature, survey of state departments of transportation (DOTs), DOT interviews, and geographic information system (GIS) analysis.

The academic literature review found a lot of interest in understanding how ROWs can be used as pollinator habitat. In general, the review found that planting pollinator habitat along roadways tends to increase pollinator abundance and diversity, and thus is recommended. Roadways can create some barriers for pollinators, including making it difficult for smaller pollinators to cross roadways, but larger bodied pollinators tend to be able to safely cross roadways. The review also found that there are certain hotspots along roadways where many pollinators are killed by vehicle collisions, but these spots are difficult to predict until built, and thus once discovered, these hotspots should be mitigated. The effects of roadway management (e.g., mowing) on pollinator populations is still an active area of research, and thus no conclusions were reached on this particular topic.

The practitioner literature review found that various practitioner resources are available regarding site assessment, best management practices (BMPs), planting guidance, and other topics related to promoting pollinator habitat within the ROW. For example, the Federal Highway Administration (FHWA) website on pollinators provides links to different types of resources, including legislation, policies and guidance, FHWA pollinator publications and webinars, pollinator-friendly practices, funding opportunities, and state Department of Transportation (DOT) information.

For site assessment, guides developed by the Ohio DOT and Pollinator Partnership include forms to evaluate the suitability of a particular site for pollinator habitat based on various factors such as cover and health of existing vegetation, mowing frequency, soil texture and pH, land use, site size, sunlight, water availability, and accessibility. In addition, the following four products from NCRHP project 20-119 (Evaluating the Suitability of Roadway Corridors for Use by Monarch Butterflies) are freely provided to DOTs: Landscape Prioritization Model for Roadside Habitat for Monarchs, Rapid Assessment of Roadside Habitat for Monarchs protocol and tool, Roadside Monarch Habitat Calculator, and decision-support tools.

Direction regarding BMPs for pollinator habitat is available from various sources, such as FHWA, the Pollinator Partnership, Colorado DOT, Purdue University Extension, Minnesota Department of Agriculture, and Ohio DOT. According to a FHWA guide on BMPs for roadside

pollinators, suggested roadside vegetation management practices include inventorying existing vegetation and invasive species, protecting existing habitat, identifying areas with high potential for pollinator plantings, limiting mowing and herbicide use, and training maintenance personnel to recognize native plants and invasive species. While the availability of research studies to evaluate the effectiveness of BMPs for roadside pollinators is very limited, a field study in Maryland found that selective herbicide use and an annual fall mow led to increases in floral diversity and bee population.

Planting guides from state DOTs such as North Carolina and Maine provide direction regarding setbacks, landscaping layouts, and plant selection for pollinator habitat. Lists of suitable plants and their characteristics are available for several states, including Indiana, Maine, North Carolina, and Ohio.

Pollinators have a role in the agricultural economy in Missouri. This role is important, whether in producing the fruit or other plant parts that we eat, allowing plants to produce seeds, enhancing genetic diversity, or improving the size, shape, and quality of the fruit that is produced. The impact is on both specialty (i.e., fruits, tree nuts, vegetables, nursery and floriculture crops and other horticultural goods) and non-specialty crops (including soybeans, cotton), and on both large and small producers.

In addition to the literature review, an assessment of DOT practices for promoting pollinator habitat within the ROW was undertaken through an online survey and DOT interviews. The survey, which included 16 questions, was reviewed by the Technical Advisory Committee before being sent to the DOTs for each state and the District of Columbia. The contact list for the survey was developed based on the member list for the AASHTO Committee on Maintenance. Responses were received from 46 DOTs for a 90% response rate. Interviews were conducted with the following five states: Arkansas, Iowa, Minnesota, Virginia, and Washington.

Results from the review of DOT practices indicate that the most frequently utilized methods for promoting pollinator habitat in the highway ROW are planting native species that benefit pollinators, limiting the frequency of mowing, and vegetation management practices. DOTs perceive the designation of right of way on DOT facilities and reclassification of existing habitat as the most effective methods for promoting pollinator habitat. Shortage of agency staff is the most commonly reported obstacle to promoting pollinator habitat within the highway ROW. Regarding the location of pollinator habitat, DOTs use a wide range of offsets from the edge of pavement to the pollinator habitat, with the clear zone width or obstruction free zone width most frequently used. In addition, over half of the survey respondents indicated that their agency does not generally provide pollinator habitat in the median.

With regard to planting practices, the survey results show that DOTs most frequently consider climate and existing vegetation when determining where to plant native pollinator habitat species within the highway ROW. Milkweed and Black-eyed Susan are the most commonly utilized

species for providing pollinator habitat within the highway ROW. DOTs use different seed mixes to promote pollinator habitat within the ROW, and the makeup of these seed mixes can vary based on land use, purpose of the planting, and geographical location. DOTs most frequently plant for pollinator habitat during the fall and spring. Seed drilling is the method most often used by DOTs to plant pollinator habitat within the highway ROW, and other deployed methods include broadcast seeder, hydroseeding, and native shrubs in containers. When determining a seed mix for newly constructed ROW pollinator habitat, we suggest contacting Sam Lord with the Missouri DNR (Sam.Lord@dnr.mo.gov) who will help build a seed mix that will work in the specific area.

Information regarding the use of vegetation management practices to promote pollinator habitat within the ROW was also obtained through the survey and DOT interviews. Guidelines for vegetation management and mowing policies have been developed by the majority of DOTs that responded to the survey. DOTs use various integrated roadside vegetation management (IRVM) techniques to help promote pollinator habitat within the ROW, such as mowing practices, prescribed burning, herbicides, and biological controls for specific weeds. Some DOTs divide the ROW into sections with different vegetation management practices in each section. With respect to mowing, DOTs tend to mow the clear zone or obstruction free zone and medians 60 feet or less in width more frequently than other areas. In addition, there is a wide range of DOT practices regarding a final mow out at the end of the season, and DOT opinions regarding the effectiveness of a final mow out to promote spring growth of pollinator habitat are divided.

Highway ROWs provide ample opportunities to enhance pollinator services which may also help improve biodiversity in adjacent areas. Landscape connectivity and diverse vegetation are important for pollinators as they provide food, shelter and nest sites. The linear shape and extensive connectivity of ROWs create corridors that can facilitate the movement of entities between fragmented habitats to more established larger natural landscapes such as parks and help maintain viable populations in the long-term and increase diversity. The linear corridors like highway ROWs need not always be directly connected to larger patches for species to disperse; rather, they can serve as stepping stones. A geographic information system (GIS) has been used to analyze multiple data layers (including ROWs, public lands and bodies of water, and land use/land cover) to quantify potential available land for pollinator habitat development and connectivity with other natural landscapes. A 500’ buffer around the ROW parcels was used to identify potential intersections with parks, natural areas and bodies of water. GIS files transmitted with this report will allow MoDOT to examine the locations of upcoming projects to identify those warranting further consideration as pollinator habitat.

ACRONYMS

ArDOT	Arkansas Department of Transportation
DOT	Department of Transportation
FHWA	Federal Highway Administration
GIS	Geographic information system
IRVM	Integrated Roadside Vegetation Management
MnDOT	Minnesota Department of Transportation
NCHRP	National Cooperative Highway Research Program
ROW	Right of Way
SH	Selective herbicide
VDOT	Virginia Department of Transportation
WSDOT	Washington State Department of Transportation

1. INTRODUCTION

Pollinators are important components of our ecosystems, as well as being important contributors to agricultural production. As with many species, grassland habitat loss has been a factor in the decline in population size, and the services these pollinators provide (e.g., pollination of crops and native plants). Efforts have been undertaken to preserve and/or recreate native habitat that support these pollinators. If a governmental agency or a conservation organization is interested in pursuing such efforts, several questions arise, ranging from large-scale habitat questions to small-scale implementation questions. Some examples of large-scale questions include: can diverse habitat be created, can individual habitat plots be connected, and can created habitat plots serve to support viable populations of pollinators? Intermediate scale questions, directly relevant to the food supply, may relate to the support of nearby agriculture and the potential impact of agricultural activities on grassland habitat. Smaller scale questions may include which pollinators may be of interest in conserving, do specific pollinators require different habitat and how does one site and create grassland habitat.

Grassland habitat reconstruction in such a specialized environment such as a highway right of way (ROW) presents additional questions that must be answered before decisions can be made. It is necessary to understand how these ROWs would serve as functioning habitat, which would inform design, implementation and maintenance activities. In addition to the specific questions that MoDOT has asked (e.g., what are locations, plants, and process for creating successful pollinator habitat) there are other questions that should be explored. ROWs are linear in configuration, so questions may arise, such as: Are there any minimum widths that would be required for creating functioning pollinator habitat? Are there places within the ROW where they should be placed? Would it be possible to leverage potential pollinator habitat activities for other MoDOT responsibilities, such as stormwater management and decreased mowing costs? How might pollinator habitat impact runoff infiltration in the context of issues such as a return to predevelopment hydrology? Related to stormwater management, the implications of chloride runoff from roadway surfaces onto the ROW should be explored. Additionally, questions related to ensuring safety as in line-of-sight, are also of interest.

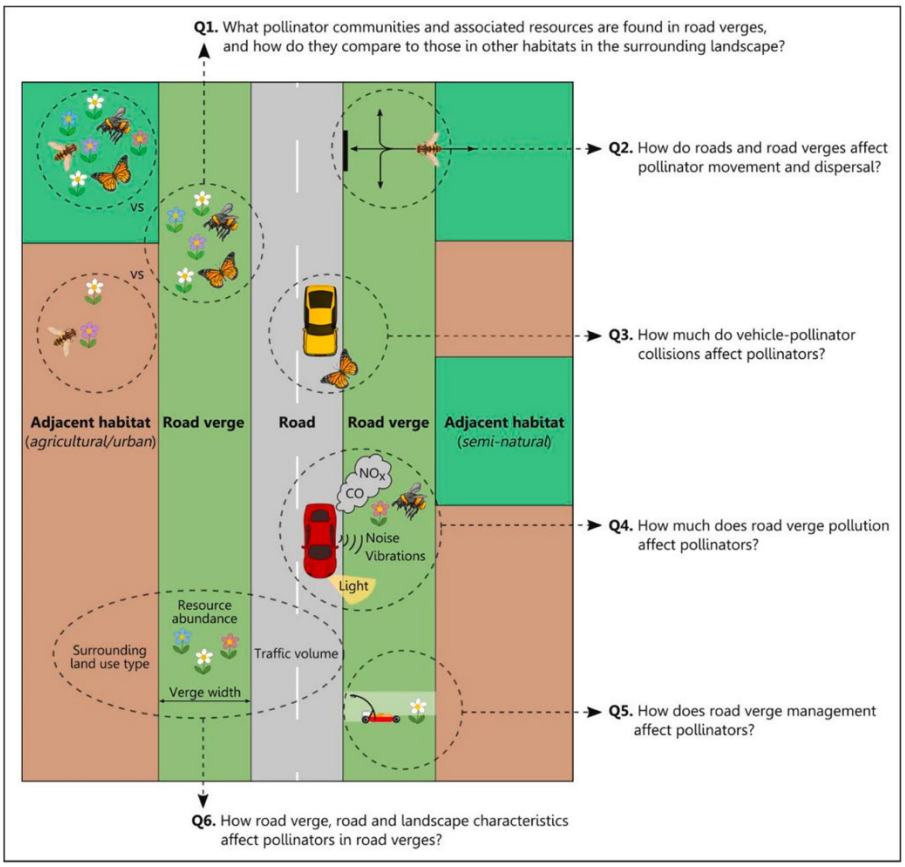
For this project, an interdisciplinary team from the University of Missouri (MU) has been assembled to research the questions that encompass the natural environment and the built environment. The research team performed a literature review, communicated with officials in other state departments of transportation and in organizations/agencies with expertise related to pollinator habitat, and consolidated all of the information into the guidance reported here to inform MoDOT decision-making on whether and how to convert ROWs into pollinator habitat. The disciplines included in the literature review encompass the biological sciences, agriculture and geographical information science.

2. LITERATURE REVIEW

In order to develop a set of recommendations for how MoDOT might use highway rights of way (ROWs) as pollinator habitat in Missouri, we reviewed the academic literature to determine what is known based on experimental data collection. We also surveyed state Departments of Transportation (DOTs) to determine their management strategies and recommended best practices for these ROWs.

Review of Academic Literature

The academic literature has been focusing on issues related to pollinator use of highway ROWs (or "road verges" as much of the European literature calls them) for the last 10-12 years, with a large increase in studies in the last 3-5 years (Phillips, Wallace, et al. 2020), indicating a strong increase in academic research interest. Within the academic literature, ROWs are defined as a managed strip of land between a road, and the adjacent habitat. These ROW's make up a considerable amount of land across the globe - 270,000 km^2 globally (Phillips, Bullock, et al. 2020), with 50,000 km^2 (0.5% of land) in the U.S. alone (Forman et al. 2003). While there is evidence that ROWs can harm organisms that may use the road-adjacent habitat via vehicle collisions and pollution (Gardiner et al. 2018; Muñoz, Torres, and Megías 2015), there is also potential benefit that can be provided by these ROWs (Phillips, Bullock, et al. 2020), especially for organisms such as pollinators. A recent review focused on understanding how ROWs can support pollinator conservation (Phillips, Wallace, et al. 2020). We use this timely review as a basis for our report and cite appropriate papers of interest within. The article describes what is known about several important research questions related to pollinator conservation on ROWs (Figure 1).



(Phillips, Wallace et al. 2020)
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Figure 1. A description of ROWs (road verges) and the research questions reviewed in Phillips, Wallace et al. 2020

Creating Pollinator Habitat on ROWs

In Missouri, and elsewhere, wildflower (or often referred to as "forbs") habitat supports pollinator populations. There is overwhelming evidence that high diversity, forb-rich habitat can be maintained on ROWs (Jakobsson et al. 2018; Gardiner et al. 2018), and thus, ROWs can support native plant diversity in their own right. Studies demonstrate that by containing high plant diversity, ROWs support the food resources necessary for pollinators (Phillips et al. 2019; Noordijk et al. 2009), as well as the hostplants necessary for larval survival (Valtonen, Saarinen, and Jantunen 2006). As such, these habitats support a high diversity of pollinators (Phillips et al. 2019; Valtonen, Saarinen, and Jantunen 2006; Hopwood 2008). Highways in the U.S. are particularly important for providing milkweed populations that support monarch butterflies as they migrate, especially when alternative habitats are scarce (Kasten et al. 2016).

ROW pollinator habitat can be created in two ways, by directly seeding native pollinator-friendly species onto bare ground after construction, or by seeding into existing low diversity (often

grass-dominated) habitat. Seeding native grassland species onto bare ground tends to produce the most forb-rich outcome (Rowe 2010), thus, ROWs created directly after road construction or intense maintenance are more likely to produce habitat that has the most potential to support pollinators. When seeding onto bare ground, high-density seedings that contain a large number of forb species will result in the highest quality habitat for pollinators due to the comparably higher forb density (Carter and Blair 2012; Rowe 2010). These seedings most often take place in the dormant season (fall/winter) (Rowe 2010). Seeding a higher forb:grass ratio is recommended because grasses tend to outcompete the forbs through time (Baer et al. 2002; McCain et al. 2010). Creating ROW pollinator habitat from existing vegetation (i.e., seeding into existing vegetation and not onto bare ground) is less likely to result in successful pollinator habitat, and requires some form of site preparation including a combination of tilling, fire, mowing, or herbicide application (Rowe 2010).

How ROWs Do and Do Not Support Pollinators

In general, the academic literature supports the notion that ROWs provide higher quality flowering habitat and pollinator populations than adjacent agricultural fields, and support about equal quality habitat and pollinator populations to adjacent woodlands, however, are of lower quality than adjacent grasslands (Phillips, Wallace, et al. 2020; Osgathorpe, Park, and Goulson 2012; Phillips et al. 2019). While few studies examined how ROW habitat influenced pollinator populations beyond abundance and densities (e.g., little examination of the insect life cycle), the exception is for monarch butterflies. As with other forbs, ROWs tend to increase the abundance of the important milkweed hostplant for monarchs (Kasten et al. 2016) (although the densities on ROWs are still below those found in remnant prairies (Kaul and Wilsey 2019)). These hostplants tend to have 25-50% less monarch eggs per plant than those found in non-roadside habitats (Kasten et al. 2016; Pitman, Flockhart, and Norris 2018), indicating the population sizes could decrease within ROWs. Despite the promising effects of ROWs for promoting pollinator habitat, more work should be done to explore how ROWs influence the life cycle of these pollinators.

ROWs can serve as either an impediment to pollinator movement should they not be able to move across roadways or can serve as movement corridors should pollinators move parallel to the roadways. The meta-analysis found that larger-bodied pollinators that tend to fly for long distances like monarchs, bumblebees, and insects that use large-scale environmental factors like wind for movement, are not impeded significantly by roadways (Mora Alvarez, Carrera-Treviño, and Hobson 2019; Chapman et al. 2008; Phillips, Wallace, et al. 2020; Bhattacharya, Primack, and Gerwein 2002). However, smaller-bodied pollinators tend to not cross roadways as they are not physically able to do so, and thus become isolated from the habitat on the other side of the road (Phillips, Wallace, et al. 2020; Greenleaf et al. 2007; Andersson et al. 2017). There is conflicting evidence as to whether traffic volume influences the crossing likelihood of these larger-bodied pollinators, as some studies did not find a difference in crossings on heavily and less trafficked roads (Remon et al. 2018), while others found crossings tended to occur more often on roads with lower traffic volume (Valtonen and Saarinen 2005). ROWs also appear to

serve as habitat corridors and promote pollinator movement between otherwise isolated habitat patches. Several studies on Lepidoptera (butterflies and moths) demonstrated that ROWs promoted movement between habitat patches and functioned as corridors (Brunzel, Elligsen, and Frankl 2004; Villemey et al. 2016), while others found this movement only occurred for certain species and only when the ROWs provided suitable habitat (Söderström and Hedblom 2007). Interestingly, one study found that honeybees use linear landscape features (i.e., gravel roads, habitat patch boundaries, hedge rows) as a source of navigation, and thus moved along them (Menzel et al. 2019). Despite the potential for ROWs to promote connectivity on the landscape, more studies are needed to fully understand their effect (Phillips, Wallace, et al. 2020).

Pollinators can be killed by vehicles along roads, and because pollinators (especially monarchs) are a species of interest to many, the issue of the impact of ROWs for pollinator casualty is an emotional topic. The study of pollinator casualty as a result of roadway traffic is an emerging field of research, and so the results vary as to pollinator mortality (Phillips, Wallace, et al. 2020). In general, many insects are killed by vehicles along roadways (Baxter-Gilbert et al. 2015; Keilsohn, Narango, and Tallamy 2018; Shyama Prasad Rao and Saptha Girish 2007; Skórka et al. 2015). However, because measures are not always taken as a relative rate of mortality for the local population, they may be inflated. In addition, there is not clear evidence of the population effect of this mortality for pollinators. One study that examined the relative mortality rate of pollinators found that the death rate from collisions was much less than for that of natural mortality causes such as parasitoids (Munguira and Thomas 1992). While the academic literature is still inconclusive on the size of the effect of roadway collisions for pollinators, there is evidence that certain areas along roadways become mortality hot spots (Baxter-Gilbert et al. 2015; Skórka et al. 2015; Mora Alvarez, Carrera-Treviño, and Hobson 2019; Keilsohn, Narango, and Tallamy 2018; Tracy et al. 2019). While it is difficult to predict where these hotspots will occur before roadways are created, once identified, these areas should be managed to reduce roadkill (Phillips, Wallace, et al. 2020).

Pollinators can also be influenced by road pollutants, but this is also an emerging area of research (Phillips, Wallace, et al. 2020). The difficulties in understanding these processes are that observations taken from the field make it difficult to tease out the direct effect of a pollutant, while in-lab studies that directly control pollutants put pollinators in conditions that they are unlikely to face in the wild. Some of the potential pollutants include light pollution, road salts, heavy metals, exhaust, and noise. While there is conclusive evidence that light pollution from traffic and street lights can negatively affect pollinators (Phillips, Wallace, et al. 2020), more work needs to be done to understand how other pollutants affect pollinators under field conditions.

Mowing ROWs to Support Pollinator Habitat

Management of ROW grasslands will be critical to promoting pollinator habitat and driver safety. Understanding ROW management effects on pollinators is one of the largest unknowns in

the academic literature (Phillips, Wallace, et al. 2020), in part because this is a burgeoning field of research, and in part because management and pollinator communities vary, and thus so will their interaction. In general, it is recommended to mow more frequently the year that the ROW habitat is being constructed in order to reduce weed pressure (Rowe 2010). However, as the pollinator habitat becomes established, there are concerns about frequent mowing as it can have negative effects on pollinators (Phillips, Wallace, et al. 2020). In general, the recommendation is to mow ROWs 0-2 times per year. Mowing must occur at some frequency (0-1 times per year on an alternating basis) to keep woody trees from invading the system. Research found that 1-2 mowings per year, especially with the removal of cuttings, can promote increased flower density for pollinators (Phillips, Bullock, et al. 2020; Jakobsson et al. 2018; Noordijk et al. 2009). However, the timing of these mowings is essential, as if timed incorrectly they will remove many flowering heads. Early spring mowings are recommended. If more mowings are necessary, a tiered mowing system is suggested, where there are more frequent mowings directly adjacent to the roadway (2 per year), then a strip with 2 mow per year a bit further from the road, and finally, the section of the habitat farthest from the road should be mowed 0-1 times per year (with perhaps alternating schedules so trees do not grow if this is not desired) (Phillips, Wallace, et al. 2020).

One area of research that have very few associated studies is how mowings directly affect pollinator abundance, mortality, and specifically mortality at key times of their life cycle (Phillips, Wallace, et al. 2020). There is some evidence that honey bees do not avoid mowing equipment and thus are killed (Phillips, Wallace, et al. 2020). Because there are so few studies, the results of how mowings affect Lepidoptera abundance (butterflies and moths) is mixed. One study suggests that a tiered mowing strategy (or partial mowings as described above) increases adult abundance (Valtonen, Saarinen, and Jantunen 2006). And that fewer mowings (less than 2, but preferably 0-1) promote Lepidoptera abundance (Valtonen and Saarinen 2005; Saarinen et al. 2005). Studies on the timing of mowings suggest different optimal mowing timing given they study different species, thus a late fall (late September – November) or very early spring (March - April) mowing is recommended. Summer mowings (June - August) can disproportionally affect different species of Lepiodopterans, including monarchs (Knight et al. 2019; Wynhoff et al. 2011; Fischer et al. 2015).

Review of Practitioner Literature

The following sections present the results of the review of practitioner literature, including general guidance, tools, and resources, state guidance and studies, and examples of state practices.

General Practitioner Guidance and Tools

Several resources from the Federal Highway Administration (FHWA) provide guidance regarding pollinator habitat, and decision-making tools for monarch butterfly habitat were

developed in a study sponsored by the National Cooperative Highway Research Program (NCHRP). A FHWA guide on Best Management Practices (BMPs) for roadside pollinators discusses methods to benefit pollinators by modifying roadside management practices and improving and restoring native vegetation (FHWA 2016). According to the FHWA BMP guide, suggested roadside vegetation management practices include inventorying existing vegetation and invasive species, protecting existing habitat, identifying areas with high potential for pollinator plantings, limiting mowing and herbicide use, and training maintenance personnel to recognize native plants and invasive species. Various strategies can be used to improve and restore native vegetation, such as increasing the diversity of plantings with at least 50% wildflowers in seed mixes, choosing flowering species with sequential and overlapping bloom times, emphasizing the application of local plant ecotypes, maintaining a roadside safety strip, and choosing roadside sites with low to moderate weed presence that will not be impacted by construction or pesticide drift.

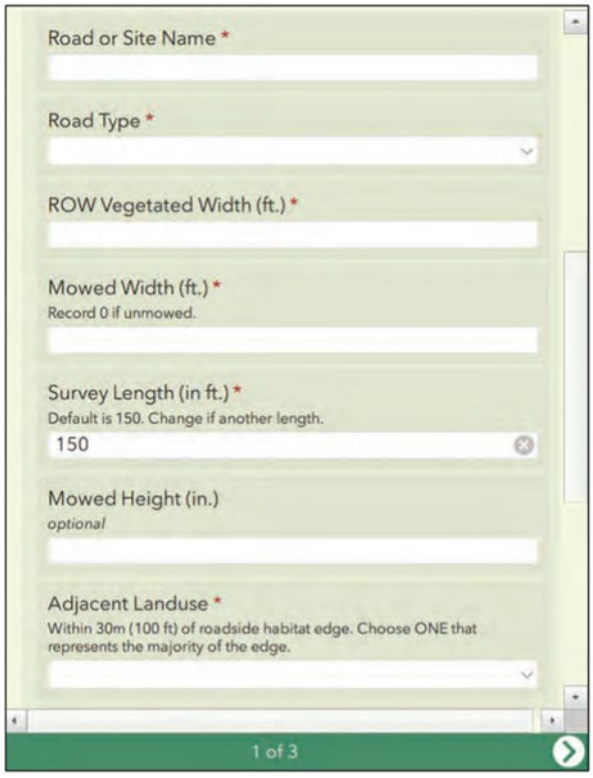
Another FHWA guide on roadside revegetation presents an integrated approach to help establish native plants and pollinator habitats along roadsides and other areas disturbed by roadside modifications (Armstrong et al. 2016). The roadside revegetation guide details the four steps in this process: initiating, planning, implementing, and monitoring and managing. A FHWA handbook describes eight BMPs with accompanying case studies (Table 1) and provides a list of pollinator-friendly plants as an Appendix (Hopwood et al. 2015b).

Table 1. BMPs and case studies in FHWA handbook (Hopwood et al. 2015b)

BMP No.	BMP Description	Case Studies
1	Protecting and Managing Remnant Habitat and Existing Stands of Native Vegetation	Oregon
2	Adjusting Mowing Practices to Benefit Pollinators	Florida
3	Reducing the Impacts of Herbicides on Pollinators	Oregon
4	Employing Multiple Vegetation Management Strategies	-
5	Designing Your Roadside Landscapes to Benefit Pollinators	California
6	Adopting Proven Native Plant Establishment Methods	Arizona, Iowa
7	Raising Public Awareness	Ohio
8	Training Your Staff	-

A technical manual from the Pollinator Partnership describes BMPs for roadside pollinators, such as planning for pollinators, site selection, plant selection, mowing and spraying practices, removal of invasive plants, Adopt-a-Highway programs, and monitoring (Galea et al. 2016). The manual also includes a rubric for evaluating the suitability of a site for pollinator habitat based on various factors such as mowing frequency, soil texture and pH, site size, sunlight, water availability, and accessibility.

NCHRP Report 942 (2020) assessed the suitability of roadway corridors for habitat for monarch butterflies and resulted in the development of four products that are freely available to DOTs: Landscape Prioritization Model for Roadside Habitat for Monarchs (in a national geographic information system (GIS) database), Rapid Assessment of Roadside Habitat for Monarchs protocol and tool (allows for roadside survey to determine suitability for monarch habitat), Roadside Monarch Habitat Calculator (determines quality scores for monarch habitat), and decision-support tools (e.g., decision tree, fact sheets for milkweed recognition by region, specific resource sheet for weeds and herbicides, and frequently asked questions) (Cariveau et al. 2020). The rapid assessment protocol and tool (Figure 2) incorporates various factors such as adjacent land use, herbicide use, mowing frequency, nectar plants, and vegetative cover. The milkweed fact sheet for Kansas and Missouri included in the appendices of NCHRP Report 942 identifies the following five common milkweed species along roadsides: swamp milkweed (*A. incarnata*), common milkweed (*A. syriaca*), butterfly milkweed (*A. tuberosa*), whorled milkweed (*A. verticillata*), and green antelopehorn (*A. viridis*).



(Cariveau et al. 2020)

Figure 2. Screenshot from roadside assessment tool for monarch habitat

NCHRP Report 942 (2020) included a survey of roadside managers from states, counties, and other agencies and a field assessment. The survey results showed significant interest in providing pollinator habitat and noteworthy differences in practices for vegetation management. Field studies in Minnesota and Oklahoma found considerable presence of milkweed, with monarchs utilizing milkweed and other nectar plants in the ROW. Overall, the study found that roadside habitat could effectively provide suitable habitat for monarchs.

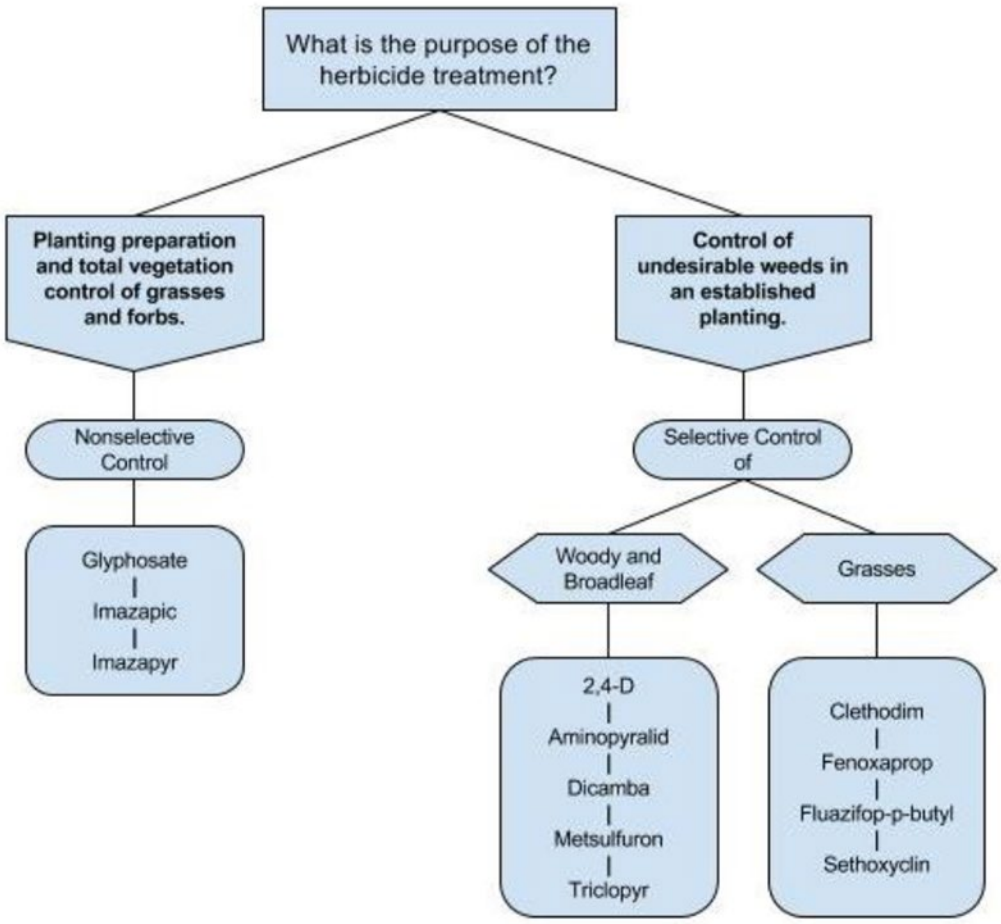
General Practitioner Resources

Various resources for promoting pollinator habitat are available to practitioners. FHWA's website on pollinators provides links to different types of resources, including legislation, policies and guidance, FHWA pollinator publications and webinars, pollinator-friendly practices, funding opportunities, and state DOT information (FHWA n.d.). The website for the Pollinator Partnership contains planting guides for regions of the United States and Canada (Pollinator Partnership 2021). Three of the guides cover different regions of Missouri: Eastern Broadleaf Forest Continental Province (southern Missouri), Lower Mississippi Riverine Forest Province (southeastern Missouri), and Prairie Parkland Temperate Province (northern Missouri). The Xerces Society furnishes links to assorted resources for pollinator conservation by region, such

as information regarding habitat assessment and management and plant lists (The Xerces Society 2021). The website for the Right of way as Habitat Working Group provides links to guidelines for BMPs, pollinator habitat scorecards, and other documents (University of Illinois-Chicago 2018).

State Guidance and Studies

Guidance and research studies regarding the promotion of pollinator habitat within the ROW are available from various states. A guide from Ohio provides direction regarding site selection, analysis, and inventory; plant selection; roadside seed mixes based on type of application; methods for site preparation and planting; BMPs for maintenance such as herbicide treatment (Figure 3) and mowing; and evaluating success based on abundance and diversity of plant species (Ohio DOT and Davey Resource Group 2016). The guide describes important criteria for evaluating site suitability, such as connectivity to existing habitats and a minimum width of 10 ft. Appendices to the guide include evaluation forms for potential sites, vegetation, and insects. The evaluation form for site suitability of pollinator habitat is based on attributes for existing vegetation conditions, soils, and site parameters. For site parameters, attributes receiving the highest score include a minimum distance from the roadway of 20 m (65 ft) and minimum area of 2 acres.



(Ohio DOT and Davey Transportation Group 2016)

Figure 3. Selection chart for herbicide treatment from Ohio

Guidance for planting for pollinator habitat is available from North Carolina and Maine. The planting guide from North Carolina includes direction regarding setbacks for both small trees and shrubs (Table 2) and large trees, setback variance, layouts for landscaping at roundabouts and interchanges, maintaining proper intersection site distance, and plant selection (North Carolina DOT 2016). A pollinator toolkit developed by the North Carolina Botanical Garden includes information for species selection, planting and maintenance specifications, timeline for establishment of pollinator habitat, and funding opportunities (North Carolina Botanical Garden 2019). A manual on Maine native plants for roadside restoration includes information on 70 plant species (e.g., natural habitat, growing conditions, associated wildlife, mowing strategies, bloom time, and seed collection and propagation) and lists of plants for different soil conditions (McCargo 2018). Example information for milkweed from the Maine guide is shown in Figure 4.

Table 2. Minimum setbacks for small trees and shrubs from North Carolina planting guide (North Carolina DOT 2016)

Posted Speed	Section	Description	Distance Clear Zone (setback)
≤ 35 mph	Curb & Gutter	to foliage line of shrub	1’
≤ 35 mph	Curb & Gutter	to center of small tree	5’
≤ 35 mph	Shoulder	to foliage line of shrub	2’
≤ 35 mph	Shoulder	to center of small trees	8’
>35 – 45	Curb & Gutter	to foliage line of shrub	6’
>35 – 45	Curb & Gutter	to center of small tree	8’
>35 – 45	Shoulder	to foliage line of shrub	8’
>35 – 45	Shoulder	to center of small trees	10’
Greater than 45 mph	Curb & Gutter	to foliage line of shrub	10’
Greater than 45 mph	Curb & Gutter	to center of small tree	20’
Greater than 45 mph	Shoulder	to foliage line of shrub	15’
Greater than 45 mph	Shoulder	to center of small trees	20’

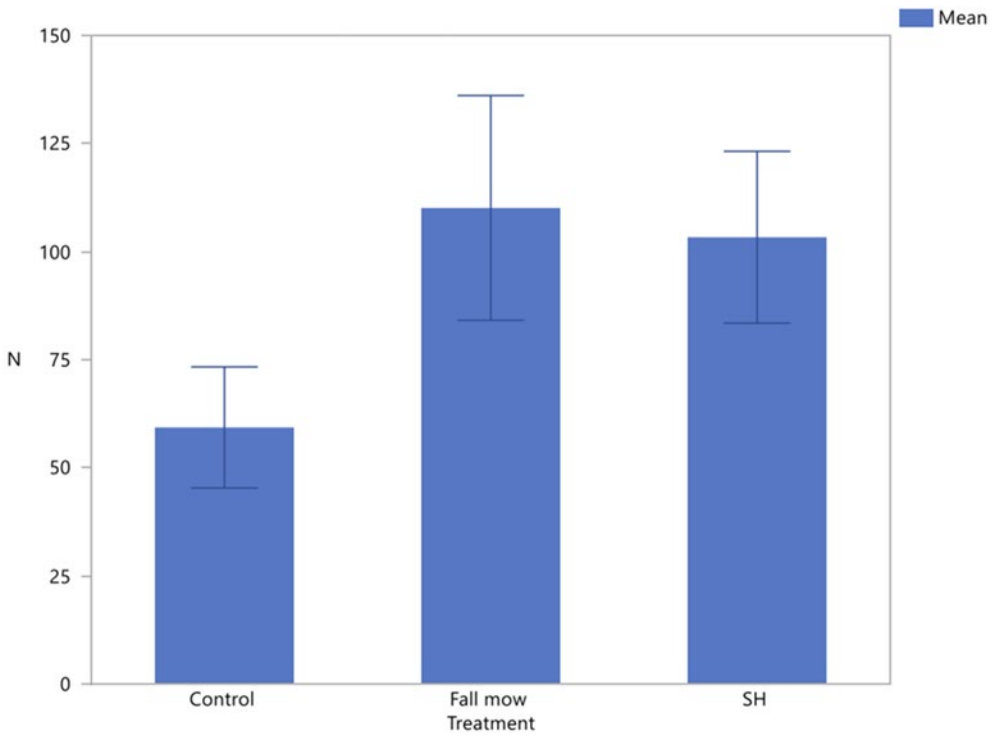
(McCargo 2018)
(Copyright © Maine Department of Transportation)

Figure 4. Example information for milkweed from the Maine guide

Guidance regarding BMPs for pollinator habitat is available from various states, such as Minnesota, Colorado, and Indiana. A brochure from the Minnesota Department of Agriculture (n.d.) presents information on assorted BMP practices, including early identification and control of invasive species, spot spraying of invasive weeds, delaying roadside mowing until late in the season, restricting mowing to the first eight feet of foreslope, planting native seed mixes during construction, establishing living snow fences, and establishing pollinator habitat at sites such as rest areas and weigh stations. Colorado's Integrated Roadside Vegetation Management (IRVM) guide discusses four ways to modify existing maintenance practices to promote pollinator habitat: reducing mowing, applying an IRVM approach, planting or seeding native species, and adding practices for management of sensitive species (Colorado DOT 2020b). The Colorado IRVM guide also suggests waiting until after Sept. 30 for mowing. A BMP guide for pollinator habitat in Indiana describes the steps for establishing and maintaining large scale plantings (Jacquart et al. 2017a). The Indiana guide suggests planting trees and shrubs from March to June to establish pollinator habitat. Maintenance BMPs described in the Indiana guide include assessing sites for invasive weeds and removing invasive species by hand or selective herbicide use. A companion document to the Indiana guide provides a table with information about Indiana-native plant species, such as requirements for sun and soil moisture, height, flower color, bloom time, and associated pollinator groups that use each plant species (Jacquart et al. 2017b).

Some states have developed plans to promote pollinator habitat based on input from stakeholders. In Arkansas, a summit of government agencies, business landowners, and other stakeholders led to the development of a state monarch and pollinator conservation plan (Arkansas Monarch Conservation Partnership 2018). Plan objectives included the establishment or restoration of 7,000 acres of pollinator habitat on public and private ROW. The plan presented various strategies for conservation, enhancement, and restoration of pollinator habitat; research and monitoring; outreach and education; and establishing partnerships. Pennsylvania developed a Pollinator Protection Plan based on feedback from 28 state and national organizations and stakeholder groups (The Pennsylvania State University 2021). The Pennsylvania plan provides guidance regarding best practices for forage and habitat and pesticide use and recommendations for research, policy, and communication.

The availability of research studies to evaluate the effectiveness of BMPs for roadside pollinators is very limited. A field study in Maryland assessed the effectiveness of vegetation management tactics for pollinators at six roadside sites (Kuder 2019). Study results indicated that selective herbicide use and an annual fall mow led to increases in floral diversity and bee population (Figure 5). The study also provided some discussion regarding implementation approaches and challenges.



(Each error bar is constructed using 1 standard error from the mean)
(SH = selective herbicide)
(Kuder 2019)

Figure 5. Mean number of bees by type of treatment in Maryland field study

Examples of State Practices

Based on the review of practitioner literature, example state practices for promoting pollinator habitat within the ROW are described below.

- Colorado maintains a database of seed mixes and plant lists, partners with advocacy groups, conducts an annual pollinator summit, and seeks to identify long term funding opportunities for pollinator habitat (Banovich n.d., Colorado DOT 2020a). In addition, a pilot project was established on several miles of I-76, with approximately 50 volunteers hand-planting pollinator species (Colorado DOT 2020c) (Figure 6).
- Illinois adopted a new mowing policy in 2017 which limits mowing to one 15-foot pass along roadsides and for other safety sensitive areas (Dobbs 2018). Mowing is not permitted between May and June 30 and between August 15 and September 30 (Illinois Farm Bureau 2019). Waystations have been established at various rest areas throughout the state.
- Indiana divides the ROW into four designated vegetation management zones (paved road, clear zone, selective zone, and zone of minimal vegetation management) and only mows the clear zone (FHWA 2015b).
- Michigan utilizes an IRVM approach with the following roadside operational zones:

pavement edge zone (regularly mowed), operational zone (prevention of encroachment by woody plants), and buffer zone (minimal maintenance) (Michigan DOT n.d.). In addition, Michigan DOT re-plants disturbed areas with native seed mixes after construction, plants wildflowers at rest areas, and establishes living snow fences.

- Nebraska limits mowing between May 1 and October 1 and establishes wildflower islands to benefit pollinators (Nebraska DOT 2020).
- New York reduced mowing frequency from three to two times per year and shifted the mowing to late summer on a pilot project on I-390 (Piecuch 2016). In addition, two interpretative gardens were established at rest areas.
- Tennessee applies integrated vegetation management practices, such as reduced mowing, and establishes pollinator habitats with native flowering plants and grasses (Figure 7) (Tennessee DOT n.d.).
- Texas mows after the spring and fall bloom seasons, uses a minimum mowing height of 7 inches, and uses spot treatments of herbicides on nonnative species (FHWA 2015a, Kurgan et al. 2016). Through its integrated vegetation management program, Texas DOT sows 30,000 pounds of native grasses and wildflower seeds each year and is working on developing regional seed mixes for pollinators. In addition, a vegetation manager is assigned to each district, and monarch waystations were created at four rest areas (Native Plant Society of Texas 2021).

(Colorado DOT 2020c)

Figure 6. Planting of pollinator species on I-76 pilot project in Colorado

(Tennessee DOT n.d.)

Figure 7. Pollinator project locations in Tennessee

Review of the Literature on the Impact of Pollinators on Agriculture

Pollinators have a role in agriculture. Some plants require pollinators to produce the "fruit" that is harvested. Some plants, such as cabbage, broccoli, and cauliflower, don't require pollination to harvest what we eat, but cross-pollination allows plants to produce seeds and improves genetic diversity. Watermelons are an example of a crop that requires pollination to produce fruit and the multiple pollination visits impact the size and shape of the fruit that is produced.

Missouri Specialty Crops

Specialty crops are defined as "fruits, tree nuts, vegetables, nursery and floriculture crops and other horticultural goods." The definition excludes grains, oilseeds, and bioenergy crops, and thus excludes corn, wheat, soybean, canola, switchgrass and alfalfa. (Missouri Specialty Crops History 2017).

In 2017, a survey was developed and distributed in an effort to quantify information about the number of and size of producers of specialty crops in Missouri (Missouri Specialty Crop Survey, 2017). According to the 469 respondents (out of 2,794 individual specialty crop producers), specialty crops are grown in 106 of the 114 counties in Missouri. The area under cultivation for these plants in 2017 was just under 11,000 acres plus an additional 1.5 million square feet under glass or afforded some other protection. While 43 producers had average yearly gross sales of $100,000 or more, there were 391 smaller producers across the state. Twelves different fruits and berries (apples, grapes, peaches, pears, cherries, plums, apricots and five different types of

berries) were being grown in 2016 by 136 producers. In the category of tree nuts, 33 survey respondents were growing five different types of trees, including chestnuts (7). There were 198 reported producers of vegetables, potatoes, and melons growing 34 different crops, including multiple varieties of melons and beans. For the category of nursery and flowering plants, there were 126 producers in the three subgroups of: (1) floriculture and bedding crops (84), (2) nursery stock crops (46), and (3) cut Christmas trees (10). This category encompassed producers with average annual gross sales in the range from less than $1,000 to more than $1,000,000. Seventy seven of the 93 producers of horticultural goods produced honey. In summary, producers large and small grow a wide range of specialty crops. Even relatively low average annual gross sales figures may be important to the health of small producers. The low response rate to the survey suggests that the information reported from the survey likely underrepresents the extent of this sector of the agricultural economy in Missouri.

All of the 12 fruits and berries reported above are pollinated by bees, representing modest to great impacts to fruit yield. Chestnuts see a modest increase in nuts with bee pollination. Within the overall category vegetables, potatoes and melons, 27 of the 34 different crops indicated above are pollinated by bees within the range of little, modest, great and essential impacts to either fruit or seed production. The honey producers indicated above require bees for their livelihood. (Wikipedia 2021)

Missouri is the seventh largest producer of watermelons in the U.S. (Missouri Agricultural Statistics Service n.d.). Animal pollination is essential for the production of this crop. “Good-sized” watermelons that have an even shape require at least eight visits from pollinators.

Non-Specialty Crops

According to the Missouri Agricultural Statistics Service (n.d.), 6% of U.S. soybeans are grown in Missouri. While soybeans are traditionally considered a self-pollinating plant, some research indicates that honeybee pollination can increase yields, so researchers at Iowa State University are conducting research on soybean yields using native bees in in-field prairie strips (Farm Progress 2013).

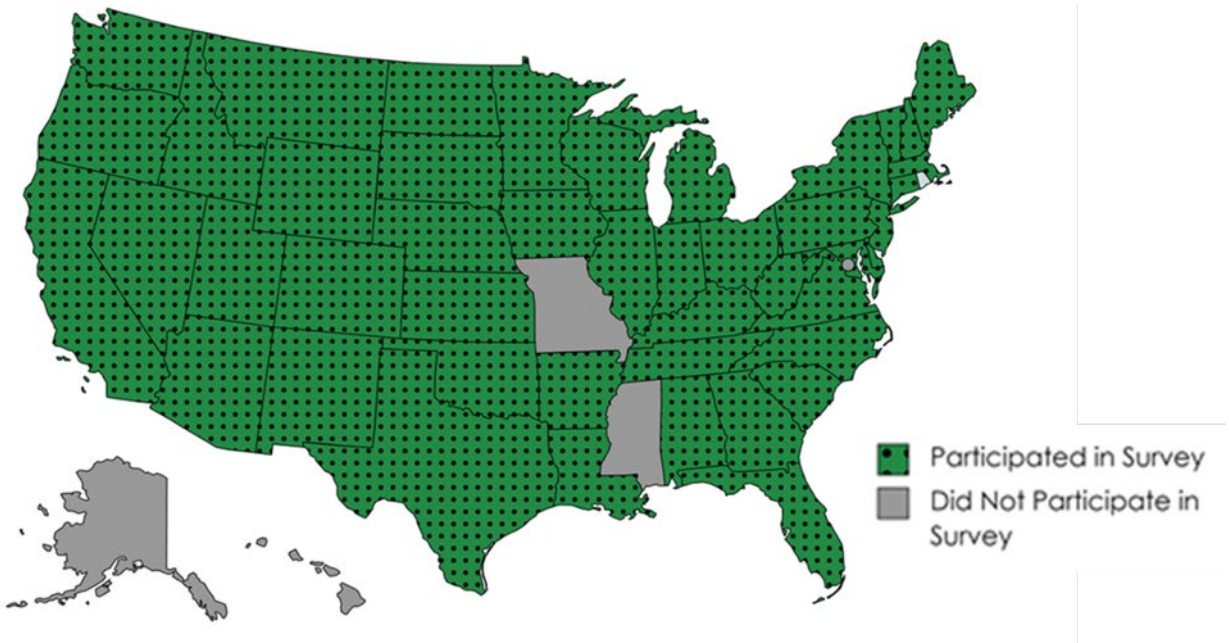
Missouri also ranks 10th in cotton production in the U.S. Cotton is again traditionally considered a self-pollinating plant, but field trials with plots with variable numbers of bee visits have produced interesting results (Rhodes 2002). The plots with the highest number of visits (vs. those with fewest visits) produced significant increases in: the total number of bolls harvested (11.1%), total mass of bolls (16.5%), total lint mass (15.8%), and total seed mass (19.7%). Additionally, there were significant increases in lint quality for micronaire and fineness.

3. DOT PRACTICES

An assessment of DOT practices for promoting pollinator habitat within the right of way (ROW) was undertaken through a survey that was sent to all 50 states and the District of Columbia and interviews with the following five states: Arkansas, Iowa, Minnesota, Virginia, and Washington.

DOT Survey

A survey was developed and administered in order to gain greater understanding of the state of the practice for promoting pollinator habitat within highway ROW in the United States. The survey, which included 16 questions, was reviewed by the Technical Advisory Committee before being sent to the DOTs for each state and the District of Columbia via Qualtrics Survey Software (Qualtrics 2021). The contact list for the survey was developed based on the member list for the AASHTO Committee on Maintenance. Although the survey was sent to one respondent from each DOT, respondents were encouraged to collaborate with others at their DOT and to forward the survey to the staff who would be most capable of answering the questions and providing the most accurate information. As shown in Figure 8, responses were received from 46 states for a 90% response rate.



(Map created with mapchart.net ©)

Figure 8. Map showing states that participated in the survey

Topics that were covered by the survey include methods used to promote pollinator habitat, factors considered, implementation considerations, practices for mowing and planting, and guidelines and policies. A copy of the full survey can be found in Appendix A. A list of

responding DOTs is shown in Appendix B, and the survey responses, including comments and resources submitted, are shown in Appendix C.

This chapter is organized into the following sections: Experience with Pollinator Habitat (survey questions 1-4), Implementation Considerations for Pollinator Habitat (survey questions 5, 6, 13, 14), Planting Practices for Pollinator Habitat (survey questions 7-9), Mowing Considerations for Pollinator Habitat (survey questions 10-12), and Other Survey Feedback (survey questions 15, 16).

Experience with Pollinator Habitat

Question 1 of the survey asked respondents which methods they use to promote pollinator habitat within the ROW. The results (Table 3) indicate that the most frequently utilized methods are planting native species that benefit pollinators, limiting the frequency of mowing, and vegetation management practices. Less than half of the responding DOTs train maintenance crews to recognize native plants and invasive weeds or plant non-native flower species that benefit pollinators. Other practices mentioned in response to this question include partnering with other entities such as utility companies, landscape design, and developing District-specific Integrated Vegetation Management (IVM) plans.

Table 3. Survey results regarding methods used to promote pollinator habitat within highway ROW (question 1)

Method to Promote Pollinator Habitat	Response
Plant native species that benefit pollinators	83%
Limit the frequency of mowing	72%
Vegetation management practices	72%
Promote the use of selective herbicides	63%
Designate ROW on DOT facilities (e.g. rest areas) to provide pollinator habitat	52%
Designate areas on the highway ROW or designate corridors for pollinator	52%
Train maintenance crews to recognize native plants and invasive weeds	46%
Other (please describe)	33%
Plant non-native flower species that benefit pollinators	24%
No Response	7%
My agency does not use any of these methods to promote pollinator habitat within the highway ROW	2%

Notes: Sort order = Response (High to Low), Cell shading based on increments of 25%, Total number of respondents = 46

Some DOTs provided additional details in the comments regarding their practices for providing pollinator habitat within the ROW. A full list of survey comments for each question may be found in Appendix C. Some of the notable comments for question 1 are summarized below (ID numbers randomly assigned to each DOT are used in lieu of state names to preserve the confidentiality of survey comments).

- Some practices are applied within specific regions of DOT 22 and not statewide.
- Approximately 80% of plant species placed by DOT 32 were native species from 2019 to 2020.
- DOT 39 exclusively utilizes rest areas for pollinator plantings.

The second question of the survey sought information regarding the perceived effectiveness of various methods to promote pollinator habitat within highway ROW, as indicated on a scale of 1 (poor) to 5 (outstanding). As shown in Table 4, designating ROW on DOT facilities to promote pollinator habitat and reclassifying existing habitat as pollinator habitat received the highest ratings. Training maintenance crews to recognize native plants and invasive weeds was the

method rated the lowest by the survey respondents. Three DOTs indicated in the comments that sufficient data were not available to assess the effectiveness of various methods.

Table 4. Survey results for effectiveness of methods to promote pollinator habitat within highway ROW (question 2)

Method to Promote Pollinator Habitat	Average Rating	Standard Deviation	Lowest Rating	Highest rating	Number of Ratings	Total Responses (Including No Opinion)
Designate ROW on DOT facilities (e.g. rest areas) to provide pollinator habitat	4.05	0.86	2	5	21	22
Reclassify existing habitat as pollinator habitat	4.00	0.63	3	5	6	6
Other (please describe)	3.89	1.54	1	5	9	9
Limit the frequency of mowing	3.71	1.01	2	5	31	31
Vegetation management practices	3.55	0.87	2	5	33	33
Plant native species that benefit pollinators	3.49	1.12	2	5	37	37
Designate areas on the highway ROW or designate corridors for pollinator	3.43	0.79	2	5	23	23
Promote the use of selective herbicides	3.31	0.97	1	5	29	29
Plant non-native flower species that benefit pollinators	3.27	1.19	1	5	11	11
Train maintenance crews to recognize native plants and invasive weeds	3.15	0.93	1	5	20	21

Notes: Sort order = Average rating (High to Low), Cell shading based on increments of 1, Total number of respondents = 46

Question 3 of the survey asked respondents for the minimum offset from the edge of pavement to pollinator habitat used by their agency. The results (Table 5) show variation in the responses, with the most responses for clear zone width or obstruction free zone width. Other widths, such as 15 feet and 30 feet, are used by DOTs. Three DOTs responded that they do not have a

minimum offset requirement. DOTs indicated in the comments that this width can vary based on certain factors, such as the ditch location, ROW width, and the presence of guardrail.

Table 5. Survey results for minimum offset from edge of pavement to pollinator habitat (question 3)

Minimum Offset from Edge of Pavement to Pollinator Habitat	Response
Other (please describe)	30%
Clear zone width or obstruction free zone width	30%
10 ft	15%
30 ft	13%
20 ft	7%
No Response	4%
40 ft or more	0%

Notes: Sort order = Response (High to Low), Cell shading based on increments of 25%, Total number of respondents = 46

Survey respondents were also asked about the minimum width used by their agency to provide pollinator habitat in the median. As shown in Table 6, over half of the respondents indicated that their agency does not generally provide pollinator habitat in the median. There is a great deal of variation in the minimum median widths for the DOTs that provide pollinator habitat in the median.

Table 6. Survey results for minimum median width to provide pollinator habitat in the median (question 4)

Minimum Median Width to Provide Pollinator Habitat in the Median	Response
My agency does not generally provide pollinator habitat in the median	52%
Other (please describe)	13%
61 ft to 80 ft	9%
41 ft to 60 ft	9%
No Response	4%
21 ft to 40 ft	4%
Less than 20 ft	4%
81 ft or more	4%

Notes: Sort order = Response (High to Low), Cell shading based on increments of 25%, Total number of respondents = 46

Some notable respondent comments for this question are as follows:

- DOT 4 plans to utilize the roadsides more frequently than the medians.
- While DOT 29 does not have a formal policy, there are some medians less than 20 feet in width where native plants have been placed.
- DOT 36 plans to designate some wide medians for pollinator management mowing.

Implementation Considerations for Pollinator Habitat

In question 5, respondents were asked how frequently various factors were considered when determining where to plant native pollinator habitat species within highway ROW. The results (Table 7) indicate that the most commonly considered factors are climate and existing vegetation. The following factors are always or almost always considered by a majority of responding DOTs: climate, type of existing vegetation, lateral offset from roadway, ROW width, type of terrain, ease of access for maintenance personnel, and availability of local native plants. Availability of local ecotypes and traffic volumes are the least frequently considered factors. Other factors taken into account by DOTs include permit requirements, surrounding land use, precipitation, long term maintenance costs, and appearance.

Table 7. Survey results for factors considered when determining where to plant native pollinator habitat species within highway ROW (question 5)

Factor	Always	Almost Always	Sometimes	Rarely	Never	No Response
Climate	46%	17%	11%	4%	9%	13%
Type of Existing Vegetation	26%	37%	11%	4%	9%	13%
Lateral Offset from Roadway	37%	24%	15%	4%	9%	11%
ROW Width	41%	20%	13%	4%	11%	11%
Type of Terrain	26%	33%	15%	7%	9%	11%
Ease of Access for Maintenance Personnel	22%	33%	20%	9%	4%	13%
Availability of Local Native Plants	26%	26%	17%	13%	7%	11%
Soil Conditions	22%	22%	26%	9%	11%	11%
Availability of Local Ecotypes	11%	20%	20%	17%	15%	17%
Traffic Volumes	9%	7%	20%	28%	26%	11%
Other (Please describe)	9%	2%	2%	0%	4%	83%

Notes: Sort order = Always + Almost Always (High to Low), Cell shading based on increments of 25%, Total number of respondents = 46

Example comments for this question are as follows:

- DOT 49 and DOT 4 perform soil testing for pollinator sites.
- DOT 39 collaborated with Game Fish and Parks and the National Resources Conservation Service (NRCS) to develop a seed mixture.
- DOT 28 considers most of the factors highly important but is not always able to incorporate them on projects due to project schedule and other constraints.

As shown in Table 8, shortage of agency staff is the most commonly reported obstacle to promoting pollinator habitat within highway ROW. At least half of the DOT respondents agree that the following factors hinder efforts for pollinator habitat: agency understaffed, staff awareness, cost associated with native habitat plantings, lack of agency buy-in, and mowing practices. Less than a quarter of DOTs find that lack of suitable soil, climate conditions, and lack of available ROW are challenges to promoting pollinator habitat. Other challenges mentioned by respondents include fire prone regions and lack of resources and expertise for maintenance.

Table 8. Survey results for concerns that hinder agency efforts to promote pollinator habitat within highway ROW (question 6)

Concern	Strongly Agree	Somewhat Agree	Neither Agree Nor Disagree	Somewhat Disagree	Strongly Disagree	No Response
Agency Understaffed	28%	41%	11%	11%	2%	7%
Staff Awareness	11%	43%	30%	7%	2%	7%
Cost Associated with Native Habitat Plantings	13%	39%	13%	28%	0%	7%
Lack of Agency Buy-In	15%	37%	13%	22%	7%	7%
Mowing Practices	15%	35%	15%	20%	9%	7%
Lack of Perceived Need	9%	35%	24%	24%	2%	7%
Herbicide Use	4%	28%	13%	28%	20%	7%
Public Awareness	7%	26%	22%	33%	7%	7%
Lack of Suitable Soil	2%	13%	30%	26%	22%	7%
Climate Conditions	7%	7%	33%	24%	22%	9%
Lack of Available ROW	9%	4%	15%	30%	35%	7%
Other (Please describe)	7%	2%	0%	0%	0%	91%

Notes: Sort order = Strongly Agree + Somewhat Agree (High to Low), Cell shading based on increments of 25%, Total number of respondents = 46

Some notable respondent comments for this question are as follows:

- DOT 6 finds that strong public support is important to the success of its pollinator program.
- In DOT 29's experience, follow-up management after public seeding and providing necessary public information are significant challenges.
- DOT 2 finds cost as compared to benefits of meeting ROW purpose and need to be a hurdle to promoting pollinator habitat.

Another implementation aspect of promoting pollinator habitat concerns the storing of information in a database. As shown in Table 9, only 30% of responding DOTs use a central database to store information such as location, composition, and density regarding pollinator habitat within highway ROW. Several DOTs indicated in the comments that they are working

towards implementation of this practice. DOT 39 utilizes a consultant to generate monthly Floristic Quality Indicator ratings for each pollinator site.

Table 9. Survey results for use of a database to store information for pollinator habitat within highway ROW (question 13)

Status of Database Use	Response
Yes	30%
No	70%
No Response	0%

Note: Total number of respondents = 46

In question 14, respondents were asked about types of resources developed by their DOT to promote pollinator habitat. The results (Table 10) indicate that guidelines for vegetation management and mowing policies have been developed by the majority of responding DOTs. Only 26% and 9% of DOTs have created pollinator habitat polices and performed evaluation studies, respectively. DOTs have also established educational and training materials for counties and field personnel and design guidelines. DOTs submitted various resources as summarized in Appendix C.

Table 10. Survey results for types of resources developed to promote pollinator habitat within highway ROW (question 14)

Resource to Promote Pollinator Habitat	Response
Guidelines for vegetation management	70%
Mowing policy	57%
Selective herbicide use policy	46%
Other (please describe)	35%
Pollinator habitat policy	26%
Cost information	20%
Evaluation studies or studies to look at economics or quantification of benefits	9%
No Response	9%

Notes: Sort order = Response (High to Low), Cell shading based on increments of 25%, Total number of respondents = 46

Planting Practices for Pollinator Habitat

The survey also sought information from DOTs regarding their planting practices for pollinator habitat, including plant species, timing of planting, and methods used for planting. As shown in Table 11, Milkweed and Black-eyed Susan are the most commonly utilized species for providing pollinator habitat within highway ROW. The majority of responding DOTs plant Milkweed, Black-eyed Susan, Coreopsis species, and Purple coneflower. Of the species listed in the survey, Brown-eyed Susan is the least commonly used. Various other species are also planted by DOTs, such as Orange coneflower, Flax, Oxeye daisy, Blanketflower, and native grasses.

Table 11. Survey results for plant species used for providing pollinator habitat within highway ROW (question 7)

Plant	Response
Milkweed (*Asclepias spp.*)	72%
Black-eyed Susan (*Rudbeckia hirta*)	65%
Coreopsis species (*Coreopsis spp.*)	57%
Purple coneflower (*Echinacea spp.*)	52%
Bluestem (*Schizachyrium scoparium or Andropogon gerardii*)	50%
Native sunflowers (*Helianthus spp.*)	50%
Other (Please describe)	50%
Indian Grass (*Sorgastrum nutans*)	48%
Blazing Star (*Liatris spp.*)	39%
Dropseed (*Sporobolus spp.*)	39%
Yellow coneflower (i.e., grayhead coneflower, prairie coneflower) (*Ratibida pinnata*)	37%
Purple or white prairie clover (*Dalea purpurea or D. candida*)	30%
Brown-eyed Susan (*Rudbeckia subtomentosa*)	17%
No Response	9%

Notes: Sort order = Response (High to Low), Cell shading based on increments of 25%, Total number of respondents = 46

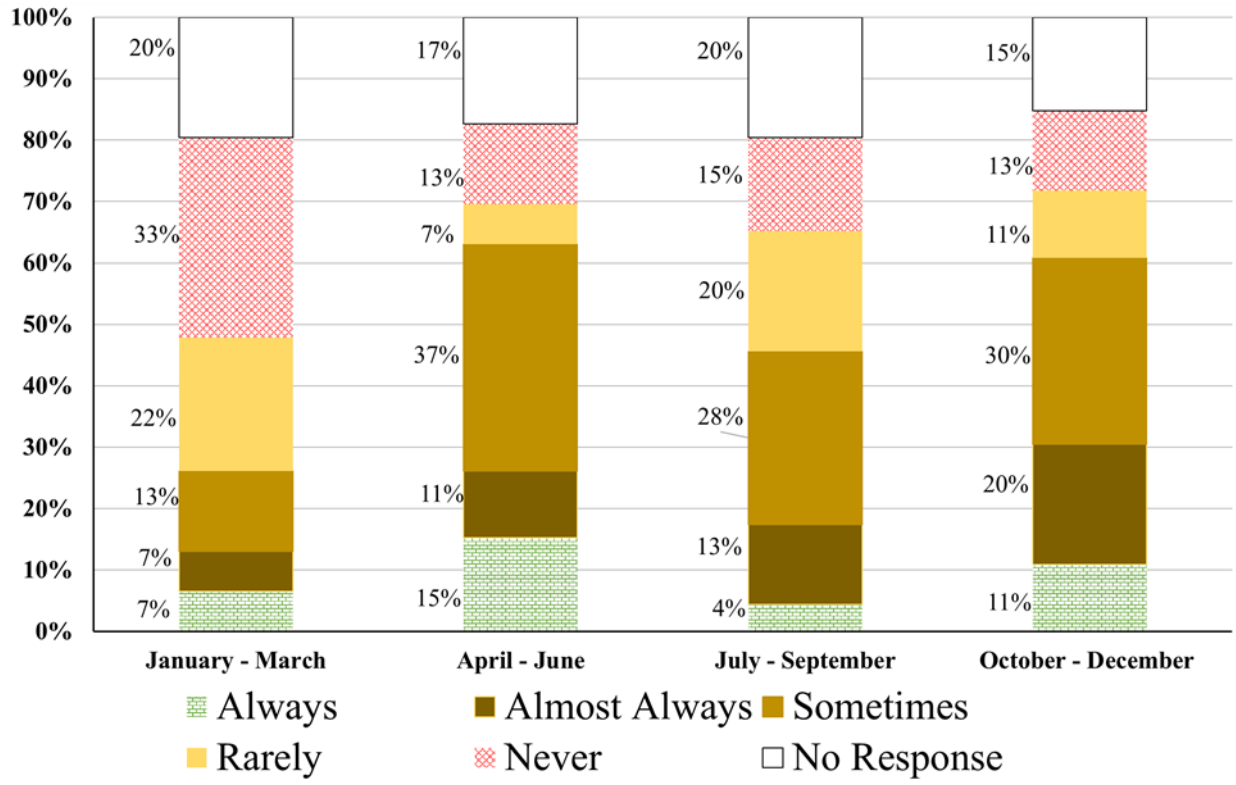
Some notable respondent comments for this question are as follows:

- DOT 7 utilizes a forbes and native grass seed mix.
- DOT 50 does not use legumes because of concerns that they can encourage grazing animals

to enter the ROW.

- DOT 4 is developing seed mixes for different regions of the state.

Question 8 of the survey sought information regarding the time of year for plantings. The results (Figure 9) indicate that DOTs most frequently plant for pollinator habitat during fall and spring. One third of DOTs avoid planting from January to March.



(Total number of respondents = 46)

Figure 9. Survey results for time of year for planting for native pollinator habitat (question 8)

Some notable respondent comments for this question are as follows:

- DOT 28 strives to plant in spring and early fall, but construction schedules and other constraints often preclude use of these time frames.
- DOT 49 has designed its seed mixes to be planted at any time of the year.
- DOT 7 plants seeds in the winter and plugs in the spring.

As shown in Table 12, seed drilling is the most commonly used method to plant pollinator habitat within highway ROW. Broadcast seeders are also utilized to some extent by almost one third of responding DOTs. Other methods include hydroseeding and native shrubs in containers.

Table 12. Survey results for methods used to plant native pollinator habitat within highway ROW (question 9)

Method to Plant Native Pollinator Habitat	Always	Almost Always	Sometimes	Rarely	Never	No Response
Seed Drill	9%	26%	26%	7%	15%	17%
Broadcast Seeder	7%	20%	30%	7%	22%	15%
Other (Please describe)	4%	13%	11%	4%	2%	65%

Notes: Sort order = Always + Almost Always (High to Low), Cell shading based on increments of 25%, Total number of respondents = 46

Example comments for this question are as follows:

- DOT 17 typically allows the contractor to decide on the method.
- Slope and site conditions sometimes prevent the use of drill seed, which is preferred by DOT 1.
- DOT 38 finds that drill seeders are challenging due to shape, size, and topography.

Mowing Considerations for Pollinator Habitat

DOTs were also asked about their mowing practices, including mowing frequency and the use of a final mow out at the end of the season. As shown in Table 13, DOTs tend to mow the clear zone or obstruction free zone and medians 60 feet or less in width more frequently than other areas. Over two thirds of DOTs mow the area outside the clear zone or obstruction free zone once per year. DOT 38 performs safety mowing as often as needed for areas where vegetation can restrict sight distance, such as intersections and horizontal curves.

Table 13. Survey results for frequency of mowing by area (question 10)

Area	Once per year	2-3 Times per Year	4 or more Times per Year	Never	No Response
Median (width 60 ft or less)	20%	46%	24%	2%	9%
Median (width greater than 60 ft)	30%	30%	17%	13%	9%
Clear Zone or Obstruction Free Zone	13%	50%	24%	2%	11%
Area Outside Clear Zone or Obstruction Free Zone	39%	15%	4%	28%	13%
Other (Please describe)	9%	7%	7%	0%	78%

Notes: Cell shading based on increments of 25%, Total number of respondents = 46

Some notable respondent comments for this question are as follows:

- DOT 14 typically mows the ROW three times per year using a 15-foot pass for one mowing and full mowings twice.
- For DOT 44, mowing frequency varies significantly based on area of the state, urban or rural location, number of lanes, and speed limit.
- For wide medians, DOT 28 sometimes mows the center less often than the areas closer to the roadway.

In question 11, DOTs were asked about their perception of final mow outs to promote spring growth of pollinator habitat and the timing of the final mow outs. As shown in Table 14, DOTs had mixed perceptions regarding the benefits of a final mow out to promote spring growth of pollinator habitat, with 28% of responding DOTs finding them beneficial, 26% of responding DOTs not finding them beneficial, and 41% of DOTs indicating no opinion. Other reasons cited for a final mow out include meeting safety requirements, animal visibility, and controlling brush, woody growth, and drifting snow. DOT 6 finds that the mow out in late fall does not encourage spring growth of pollinator habitat. DOT 2 indicated its belief that residual vegetative debris from a mow out would be harmful for insect species with respect to egg and larva overwintering.

Table 14. Survey results for perception of final mow out to promote spring growth of pollinator habitat (question 11)

Find Final Mow Out to be Beneficial	Response
Yes	28%
No	26%
No Opinion	41%
No Response	4%

Note: Total number of respondents = 46

Regarding the timing of the final mow out, results (Table 15) show that 28% of responding DOTs perform a final mow out in late fall, while 30% of DOTs do not perform a final mow out. DOT 49 indicated that the timing varies in different regions of the state, and some regions do not perform a final mow out, while snow depth affects the timing of the mow out for DOT 47.

Table 15. Survey results for timing of final mow out to promote spring growth of pollinator habitat (question 12)

Timing for Final Mow Out	Response
My agency does not typically do a mow out at the end of the season	30%
Late fall	28%
Other (please describe)	26%
After first frost	7%
During winter months	4%
No Response	4%

Notes: Sort order = Response (High to Low), Cell shading based on increments of 25%, Total number of respondents = 46

Other Survey Feedback

Questions 15 and 16 concluded the survey by inquiring into agencies' interest in participating in a follow-up interview and asking for any other general feedback. As shown in Table 16, 91% of DOTs indicated that they would be willing to participate in a follow-up interview to discuss their practices for pollinator habitat. Open feedback from DOTs can be found in Appendix C, and some notable comments are listed below.

- DOT 23 places signs within designated pollinator habitat areas at rest areas to inform the

public and encourages citizens to plant pollinator habitat through promotional materials and presentations.
- DOT 22 tries to balance many factors when promoting pollinator habitat, such as space availability, adjacent land use, and proximity to fire.
- DOT 17 perceives a need for public education outreach to promote understanding of habitat appearance.
- DOT 14 received federal funding for its program, including an effort to identify locations of rare and threatened plant species in the ROW.

Table 16. Survey results for willingness to participate in a follow-up interview (question 15)

Willing to Participate in Follow-Up Interview	Response
Yes	91%
No	9%
No Response	0%

Note: Total number of respondents = 46

DOT Interviews

Arkansas

Using IRVM Practices, the Arkansas Department of Transportation (ArDOT) divides the ROW into three parts: clear zone, transition zone, and natural zone (Ewing et al. n.d.). The clear zone and transition zone are mowed three times and one time annually, respectively. In addition, broadcast herbicides are applied to the clear zone area, which extends 10 to 30 feet from the edge of pavement, to control unwanted vegetation and meet sight distance requirements. Interstate medians are considered part of the clear zone. Growth of pollinator habitat is encouraged in the transition zone and only spot spraying of nonnative, invasive plant species is allowed.

In addition, Arkansas utilizes designated seed mixes and Wildflower Routes to promote pollinator habitat within the ROW. ArDOT's standard wildflower seeding specification includes six native wildflowers at a total application rate of 4 lbs/acre (Table 17). For projects on federal lands and other unique situations, a special wildflower seed mix with three native grasses and seven native wildflowers is specified (Ewing et al. n.d.). ArDOT finds that having legumes in the special seed mix helps to get nitrogen into the soil. ArDOT has designated over 1,000 miles of its state highway system as Wildflower Routes. Through Operation Wildflower, individuals or groups can donate plant seeds for the route of their choosing.

Table 17. Standard wildflower seed mix from Section 620 of Arkansas specifications (Arkansas State Highway and Transportation Department 2014)

Common Name	Latin Name	Application Rate (lbs/acre)
Black-eyed Susan	*Rudbeckia hirta*	0.5
Gay feather	*Liatris pycnostachya*	0.5
Purple coneflower	*Echinacea purpurea*	0.5
Showy primrose	*Oenothera speciosa*	0.5
Lanceleaf coreopsis	*Coreopsis lanceolata*	1.0
Plains coreopsis	*Coreopsis tinctoria*	1.0

(Arkansas DOT 2021)
(© Arkansas DOT)

Figure 10. Wildflower planting on Highway 412 in Benton County, Arkansas

Iowa

Since the 1960s, Iowa Department of Transportation (Iowa DOT) has planted over 50,000 acres of roadside plantings for pollinator habitat (Iowa DOT 2019). Through the Living Roadway Trust fund (Iowa DOT n.d.), approximately half of Iowa's counties have developed IRVM plans, and guidance to help counties implement IRVM is available in the state's IRVM technical manual (Brandt et al. 2015). The Iowa DOT promotes the planting of natives to counties and cities by maintaining a local ecotype seed bank with seed acquired from the Living Roadway

Trust Fund and the Iowa Tallgrass Prairie Center at the University of Northern Iowa. Yellow Tag Seed, which is certified as coming from Iowa prairies, is available from various growers (University of Northern Iowa 2021). The Living Roadway Trust Fund also developed a guide which provides information on various pollinator species (Iowa Living Roadway Trust Fund n.d.).

On Iowa DOT projects, the area outside the mow strip is seeded with native plant seed (Godbold 2019). An example pollinator roadside habitat is shown in Figure 11. Other practices to promote pollinator habitat on Iowa DOT ROW include contract spraying to control weeds, living snow fence, establishing best management practices for erosion control, and planting design for rest areas.

(Godbold 2019)

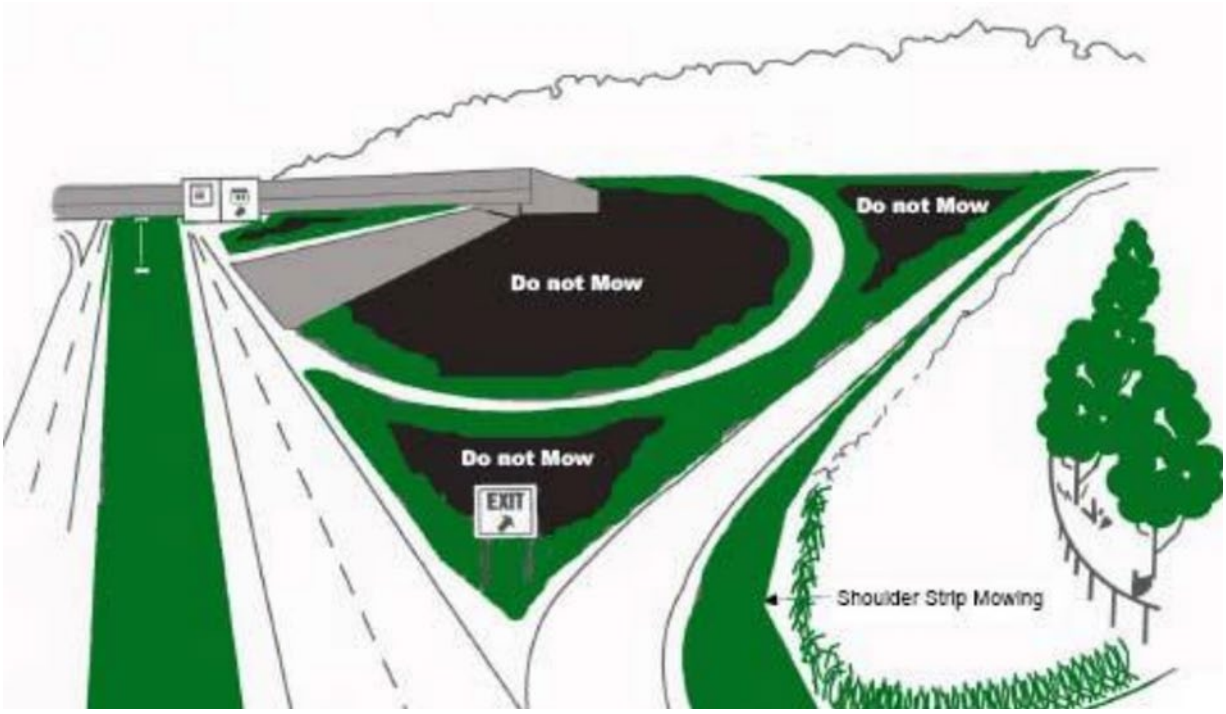
Figure 11. Example roadside pollinator habitat on I-35 near Randall, Iowa

Minnesota

The Minnesota Department of Transportation (MnDOT) plants native seed mixes on approximately one third of its construction projects when soil outside the foreslope is disturbed (Minnesota DOT 2021b). MnDOT's Seed Manual provides details for 33 seed mixes, including 23 native seed mixes (Minnesota DOT 2014). To accommodate differences in growth across the state, the Seed Manual contains a table with the recommended seed mixture based on the purpose of the planting and location within Minnesota. Average bid prices for the seed mixes varied from

$0.16 to $300.00 per lb in 2019 (Minnesota DOT 2020). In the future, MnDOT would like to see 75% of its larger projects seeded with a native mix.

MnDOT's IRVM techniques consist of mowing, prescribed burning, herbicides, and biological controls for specific weeds (Minnesota DOT 2021b). MnDOT's Maintenance Manual includes guidelines on mowing for various applications such as interchanges (Figure 12) (Minnesota DOT 2021a). While mowing practices vary by district, MnDOT typically mows at 15-foot safety cut at least one per year. For medians, the full width is mowed for medians less than 55 feet in width, while the 15-foot safety cut is used for medians 55 feet or wider. MnDOT is expanding a database used to identify locations for prescribed fire and is also working towards developing specialized maintenance plans for different areas of the state.



(Minnesota DOT 2021a)

Figure 12. Mowing locations at interchanges in Minnesota

Virginia

The pollinator habitat program for the Virginia Department of Transportation (VDOT), which was initiated in 2014 and is funded by the sale of Wildflower and Project Pollinators license plates, focuses on establishing areas of native plants along roadsides and at state-owned facilities such as rest areas and park and ride facilities (Virginia DOT 2021). As of 2021, VDOT has established pollinator habitat plots at 14 rest areas (e.g., Figure 13), four park and ride facilities, a residency facility, two district facilities, and a few other locations owned by VDOT (Virginia DOT 2021). A pollinator survey conducted at several rest areas to evaluate Crown Bee nests

placed at 11 rest areas in 2018 found a wide variety of bees and other pollinators at all sites (McCoy 2018). However, the Crown Bee nests were underutilized, possibly because they were installed late in the season.

Other aspects of VDOT's pollinator habit program include mowing practices and creating an inventory of the ROW. VDOT includes modified mowing standards in its Best Practices Manual, which recommends that mowing in "Additional Mow Areas" take place in March and/or after October 31 (Virginia DOT 2016). Typically, the clear zone area is mowed two to three times per year. For medians greater than 50 feet, the middle area is preserved. VDOT is in the process of using LiDAR to map the roadside ROW and is participating in a nationwide Candidate Conservation Agreement (CCA) for the monarch butterfly (Cardno 2020).

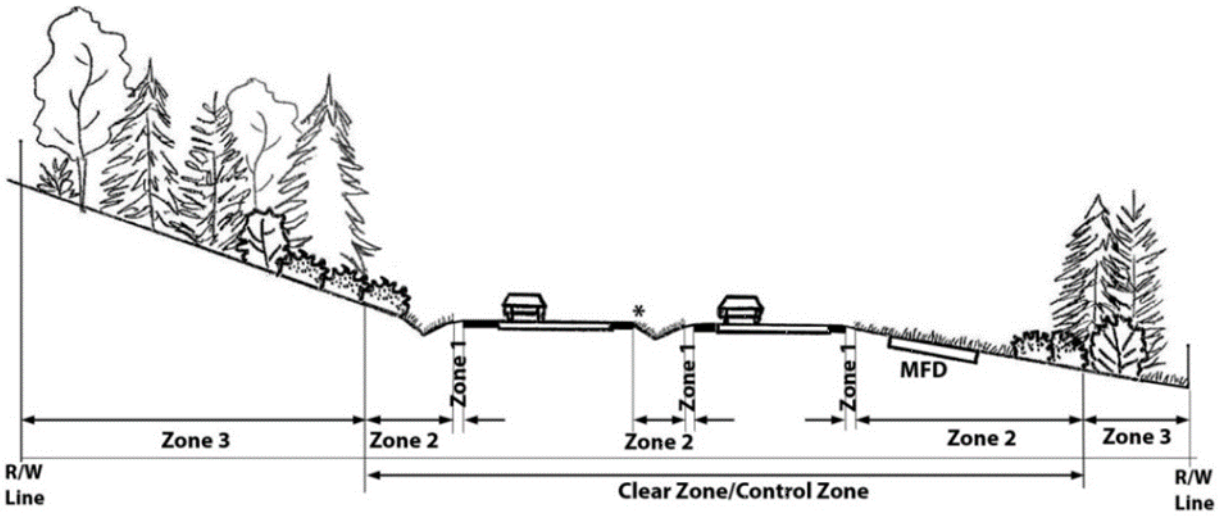
(Waymack and Moulds 2019)

Figure 13. Pollinator habitat at Dale City car-only rest area on northbound I-95 in Virginia

Washington

The Washington State Department of Transportation (WSDOT) applies different strategies to promote pollinator habitat within highway ROW, such as creating GIS models of high value areas for pollinator habitat, IRVM and ecological design practices, and beginning an evaluation study of assorted site mixes and site preparation treatments (Dreier et al. n.d.). Three GIS models (monarch butterfly habitat, pollinator habitat, and urban gateway habitat) to rank state routes for pollinator habitat were developed based on various GIS data such as urban land use, type of vegetative cover, wetland habitats, crops that depend on pollinators, conservation lands, and native grasslands (Washington State DOT 2017). WSDOT establishes pollinator habitat at various locations, including wider sections of roadside ROW, rest areas, sites for wetland mitigation and stream restoration, and natural areas preserved due to the Highway Beautification Act (Washington State DOT 2016).

WSDOT utilizes a wide range of IRVM techniques, including mowing, trimming, soil improvements, native plantings, selective herbicide use, and biological control (FHWA 2015c). IRVM plans are maintained and updated for different regions of the state (Washington State DOT 2021a). With the release of its Roadside Policy Manual in 2015, WSDOT implemented a reduced mowing policy, with the roadside divided into three zones (Figure 14) (Washington State DOT 2015). Minimal maintenance is performed in Zone 3 to promote plant growth. Areas along the pavement edge are typically mowed once per year after the blooming season. Roadsides are managed according to the principles of natural plant succession (FHWA 2015c). WSDOT finds it challenging to maintain native plantings, especially in the arid regions of the eastern part of the state.



(Washington State DOT 2015)

Figure 14. Roadside zones in Washington state

Summary of DOT Practices

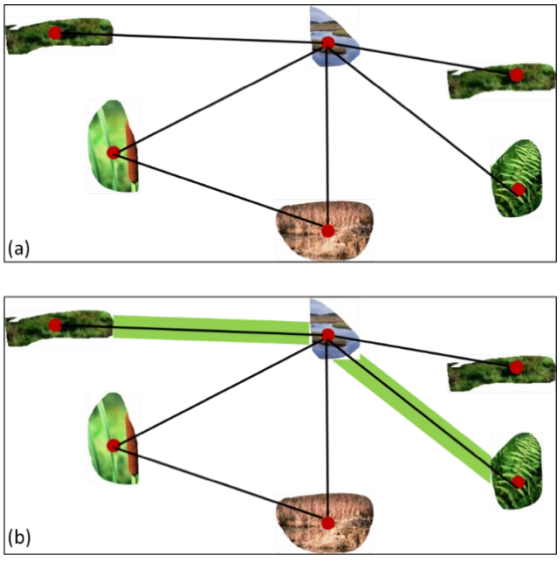
Key findings from the review of DOT practices are summarized below.

- The most frequently utilized methods for promoting pollinator habitat in the highway ROW are planting native species that benefit pollinators, limiting the frequency of mowing, and vegetation management practices.
- DOTs perceive the designation of ROW on DOT facilities and reclassification of existing habitat as the most effective methods for promoting pollinator habitat.
- DOTs use a wide range of offsets from the edge of pavement to the pollinator habitat, with the clear zone width of obstruction free zone width most frequently used.

- Over half of the survey respondents indicated that their agency does not generally provide pollinator habitat in the median.
- In determining where to plant native pollinator habitat species within highway ROW, DOTs most frequently consider climate and existing vegetation. The following factors are always or almost always considered by a majority of the DOTs that responded to the survey: climate, type of existing vegetation, lateral offset from roadway, ROW width, type of terrain, ease of access for maintenance personnel, and availability of local native plants.
- Milkweed and Black-eyed Susan are the most commonly utilized species for providing pollinator habitat within highway ROW.
- DOTs most frequently plant for pollinator habitat during fall and spring, while approximately one third of DOTs avoid planting from January to March.
- DOTs use different seed mixes to promote pollinator habitat within the ROW. The makeup of these seed mixes can vary based on land use, purpose of the planting, and geographical location.
- Seed drilling is the method most often used by DOTs to plant pollinator habitat within highway ROW. Other deployed methods include broadcast seeder, hydroseeding, and native shrubs in containers.
- Guidelines for vegetation management and mowing policies have been developed by the majority of DOTs that responded to the survey. DOTs use various IRVM techniques to help promote pollinator habitat within the ROW, such as mowing practices, prescribed burning, herbicides, and biological controls for specific weeds.
- Some DOTs divide the ROW into sections with different vegetation management practices in each section.
- DOTs tend to mow the clear zone or obstruction free zone and medians 60 feet or less in width more frequently than other areas. Over two thirds of DOTs mow the area outside the clear zone or obstruction free zone once per year.
- There is a wide range of DOT practices regarding a final mow out at the end of the season. Survey results show that 28% of responding DOTs perform a final mow out in late fall, while 30% of DOTs do not perform a final mow out at all. Some DOTs perform final mow outs for other reasons, such as meeting safety requirements, animal visibility, and controlling brush, woody growth, and drifting snow. DOT opinions regarding the effectiveness of a final mow out to promote spring growth of pollinator habitat are divided.
- Only 30% of responding DOTs use a central database to store information such as location, composition, and density regarding pollinator habitat within highway ROW, with several DOTs working towards implementation of this practice.
- Shortage of agency staff is the most commonly reported obstacle to promoting pollinator habitat within highway ROW. Other factors that significantly hinder implementation efforts based on the survey results include agency staffing shortages, staff awareness, the cost associated with native habitat plantings, lack of agency buy-in, and mowing practices.

4. GIS ANALYSIS

Pollinators services are important for natural and managed landscapes. The highway right of way (ROW) lands provide ample opportunities to enhance pollinator services which may also help improve biodiversity in adjacent areas. Landscape connectivity and diverse vegetation are important for pollinators as they provide food, shelter and nest sites. Roadside and highway ROWs spread across multiple landscapes, have the potential for greater plant diversity, and are often excluded from major developments. Due to the layouts of highway infrastructure, linear shapes and connectivity, highway ROWs help pollinators traverse through diverse landscapes for daily foraging and dispersal between larger natural habitat such as parks and forests (Saunders et al., 1991). The highway ROWs are also beneficial to managed agricultural landscapes. These corridors may be established to facilitate the movement of entities between fragmented habitats to more established larger natural landscapes such as parks, and help maintain viable populations in the long-term and increase diversity (Figure 15). The linear corridors like the highway ROW need not always be directly connected to larger patches for species to disperse; rather, they can serve as stepping stones. Detailed geospatial assessment that considers multiple biophysical factors that modulate pollinator habitat distribution/dispersion can aid in the establishment of long-term conservation plans along highways.



(adapted from Sperry, Shaw and Sullivan 2019)

Figure 15 Landscape connectivity for pollinators (a) isolated patches and (b) isolated patches connected with linear features

The geospatial data available for Missouri are listed in Table 18. These data are related to state highway and land use and land management, which can be used to quantify available land for pollinator habitat development and connectivity with other natural landscapes.

Table 18 Available geospatial data for landscape connectivity assessment.

Layer name	Description	Data Source	Spatial resolution
Highways and right of ways	This layer provides details about all the major Interstate and State roads, lengths and number of lanes	Missouri Department of Transportation	Linear and polygon features
Conservation lands	This layer provides details of all the conservation lands which come under the purview of Missouri Department of Conservation	Missouri Department of Conservation	Polygon features
Natural Lands and State Parks	This layer provides details of all the state parks managed by the Missouri Department of Natural Resources	Missouri Department of Natural Resources	Spatial polygons
Public water bodies	This layer provides details of all the public water bodies which come under the purview of Missouri Department of Conservation	Missouri Department of Conservation	Spatial polygons
Right of way parcels	This layer provides information for all the available right of way parcels in Missouri.	Missouri Department of Transportation	Spatial polygons
Land use and land cover	National land cover and land use maps for the US for several years are available. The U. S. Department of Agriculture maps are updated every year since 2008.	Multi-Resolution Land Characteristics Consortium, and U. S. Department of Agriculture – National Agriculture and Statistics Service	30m x 30m horizontal resolution raster
Topography	The digital map provides elevation details derived from satellite and aerial images.	U. S. Geological Survey	10m x 10m horizontal resolution raster

Soils	The soils database provides complete coverage of the best available gridded soils information for all areas of the United States	U. S. Department of Agriculture – Natural Resources Conservation Service	Spatial polygons

The road maps, 10m spatial resolution digital elevation model (DEM) and 30m land use/cover data can be used to quantify the land cover types available within the ROW corridors. Based on the available geospatial data, the total ROW extent is approximately 940,000 acres for a total of 70,000 lane miles. The roads and ROW parcels also pass through or are in close proximity to natural landscapes (Figure 16).

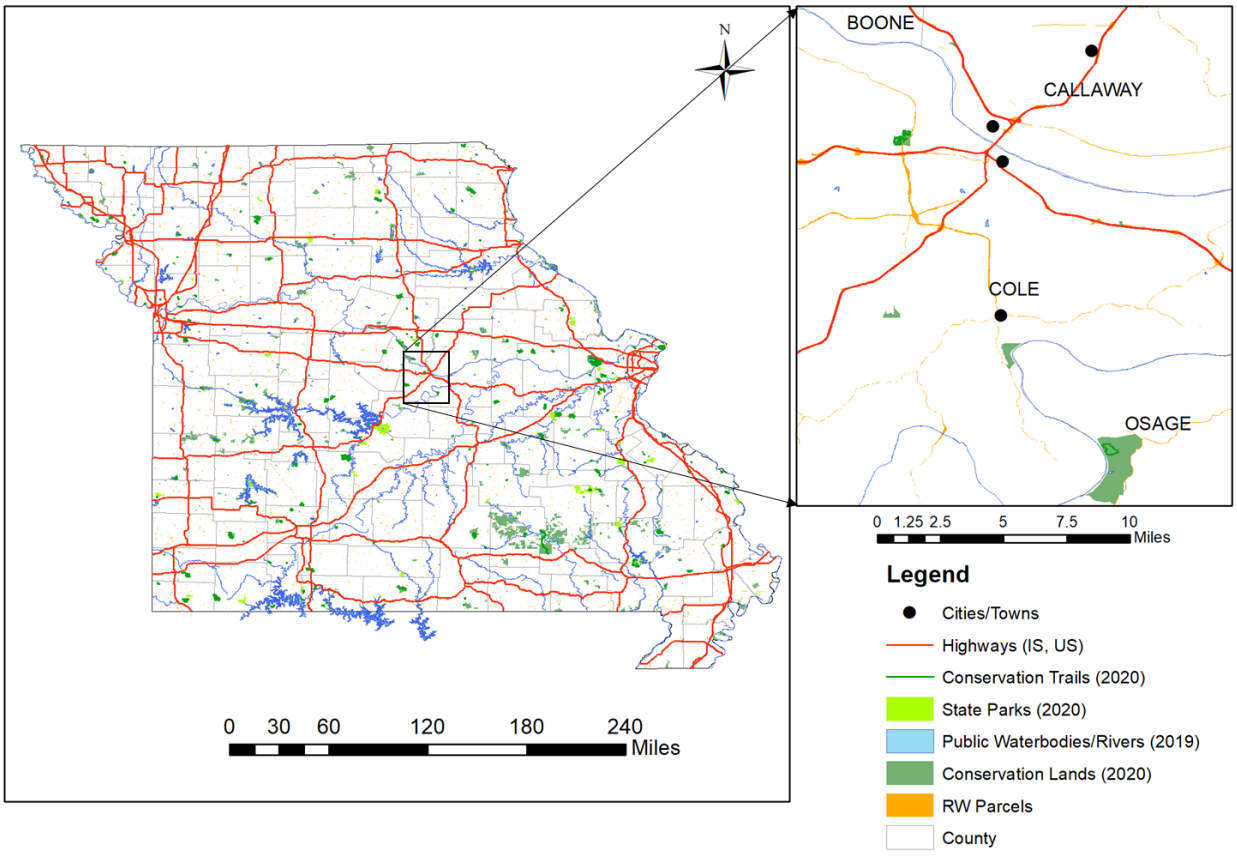


Figure 16 Landscape connectivity map showing major features that include road network, right of ways, river network, water bodies, state parks and conservation areas.

However, not all ROW parcels are accessible or suitable for pollinator habitat. A buffer and network analysis that elucidate connectivity between ROWs and other natural landscapes (Figure 15 and Figure 16) can be used to establish sites for pollinator habitat. Such assessment will help

to identify and quantify (i) land use and land cover distribution within highway buffer zone, (ii) potential threats to roadside pollinators and habitat due to land use (e.g., agricultural land distribution, pesticide and agrochemical impacts), and (iii) develop potential habitat connectivity maps outside the highway ROW (Beier et al., 2011 and Hopwood et al., 2015a). The geospatial information collected here can also be used to determine the potential habitat connectivity, including existing land features.

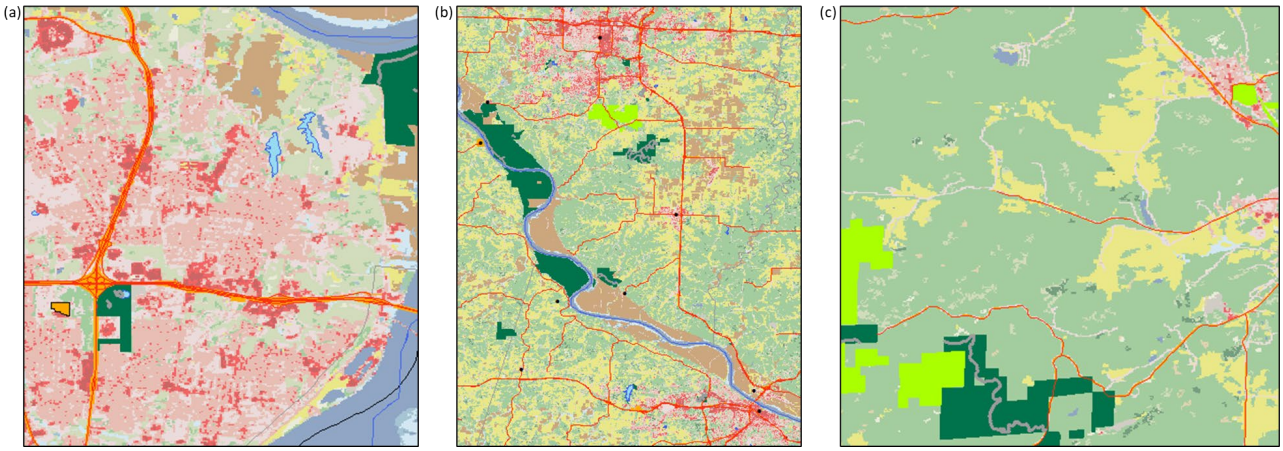


Figure 17 Road network (red lines) and Right of Way (yellow polygons) overlayed on National Land Cover of 2016. The shades of green show natural land cover types including State Parks and Conservation Areas: (a) highly urbanized areas in Saint Louis County, (b) moderately urbanized Columbia-Ashland-Jefferson City area in Mid-Missouri, and (c) sparsely populated site near the Taum Sauk Mountain State Park and the Town of Ironton.

The example sites in Figure 17 Road network (red lines) and Right of Way (yellow polygons) overlayed on National Land Cover of 2016. The shades of green show natural land cover types including State Parks and Conservation Areas: (a) highly urbanized areas in Saint Louis County, (b) moderately urbanized Columbia-Ashland-Jefferson City area in Mid-Missouri, and (c) sparsely populated site near the Taum Sauk Mountain State Park and the Town of Ironton. show the complexity of landscape connectivity at three locations in Missouri. Figure 17 Road network (red lines) and Right of Way (yellow polygons) overlayed on National Land Cover of 2016. The shades of green show natural land cover types including State Parks and Conservation Areas: (a) highly urbanized areas in Saint Louis County, (b) moderately urbanized Columbia-Ashland-Jefferson City area in Mid-Missouri, and (c) sparsely populated site near the Taum Sauk Mountain State Park and the Town of Ironton. (a) shows two major highways (Interstate 270 and MO 367) in Saint Louis County. The site is highly urbanized (shades of red) with fewer natural areas that could help establish connectivity with the Conservation Areas and the Missouri and Mississippi River flood plains. However, moderately urbanized Columbia-Ashland-Jefferson City highway ROWs Figure 17 Road network (red lines) and Right of Way (yellow polygons) overlayed on National Land Cover of 2016. The shades of green show natural land cover types including State Parks and Conservation Areas: (a) highly urbanized areas in Saint Louis County,

(b) moderately urbanized Columbia-Ashland-Jefferson City area in Mid-Missouri, and (c) sparsely populated site near the Taum Sauk Mountain State Park and the Town of Ironton. (b) (Interstate 70 and MO 63) provide more flexibility to establish connected natural landscapes.

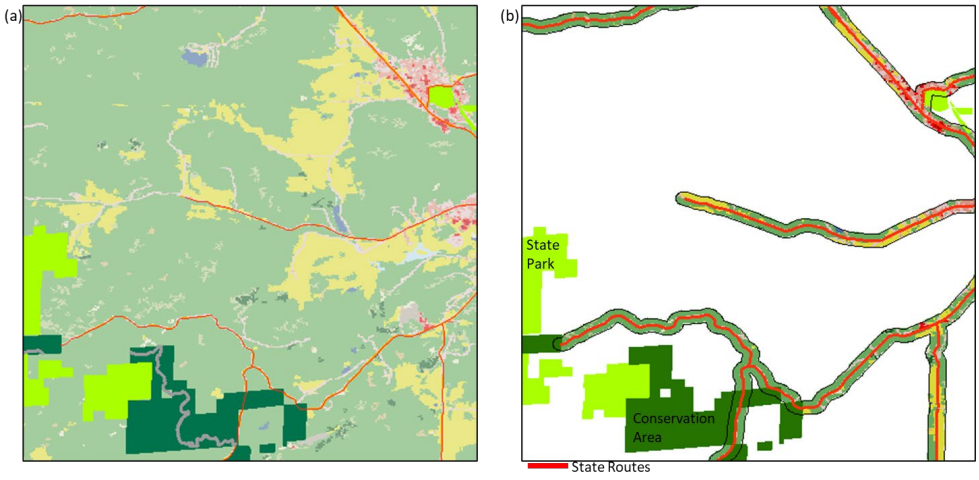


Figure 18 Road network overlayed on National Land Cover of 2016; (a) shows the general orientation of a sparsely populated site, and (b) shows land cover and natural areas connectivity within a 500 feet buffer from state routes.

On the other hand, sparsely populated sites shown in Figure 17 Road network (red lines) and Right of Way (yellow polygons) overlayed on National Land Cover of 2016. The shades of green show natural land cover types including State Parks and Conservation Areas: (a) highly urbanized areas in Saint Louis County, (b) moderately urbanized Columbia-Ashland-Jefferson City area in Mid-Missouri, and (c) sparsely populated site near the Taum Sauk Mountain State Park and the Town of Ironton. (c) and Figure 18 Road network overlayed on National Land Cover of 2016; (a) shows the general orientation of a sparsely populated site, and (b) shows land cover and natural areas connectivity within a 500 feet buffer from state routes. (areas near Taum Sauk Mountain State Park and the Town of Ironton) provide greater flexibility to establish connectivity between isolated patches (parks and conservation areas) and linear ROWs. A preliminary buffer analysis based on state routes (Figure 18 Road network overlayed on National Land Cover of 2016; (a) shows the general orientation of a sparsely populated site, and (b) shows land cover and natural areas connectivity within a 500 feet buffer from state routes. (b)) reveal that landcover types within a 500 feet buffer are 57% natural (shades of green), 26% developed (shades of red) and 17% pasture. Establishment of pollinator habitat along the linear ROW features could potentially connect state parks and conservation areas, and, thereby, providing long-term foraging sites disbursement opportunities for pollinators.

5. RECOMMENDATIONS

Based on the academic literature, below we respond to the questions raised by MoDOT from subtask 2.1.

1. *When and where should we invite pollinators to the median?*
    - The academic literature focuses mainly on pollinator habitat along roads, not in medians between them. In addition, the majority of DOTs do not provide pollinator habitat in the median. Based on this information, and the ability for small pollinators and other insects to become isolated by roadways, we do not suggest inviting pollinators to the median unless the median is quite large. However, based on the wealth of information from the academic literature, it is appropriate to create pollinator-friendly grassland habitat along roadways, and is encouraged.

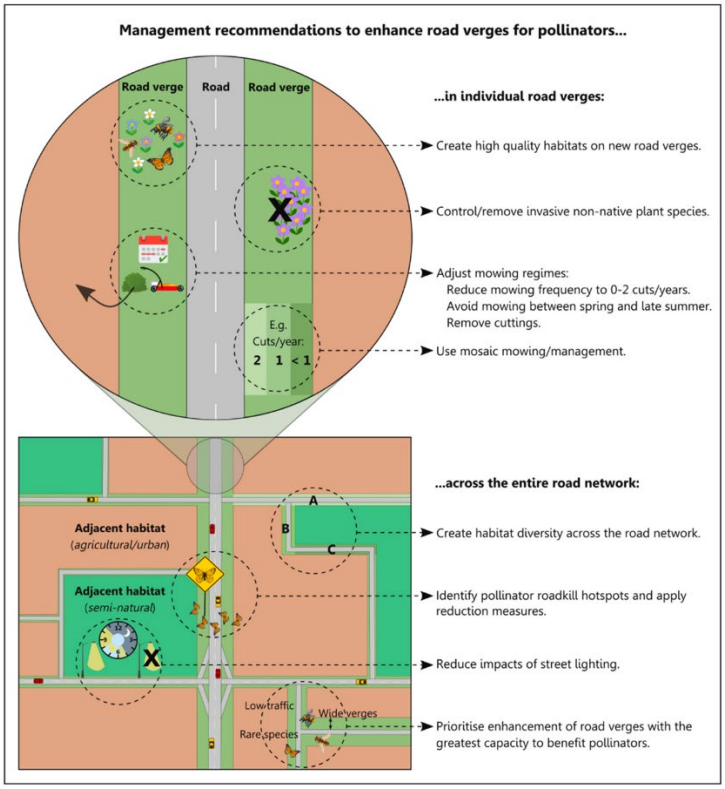
2. *How and when should we create this habitat via seeding the pollinator?*
    - The most successful pollinator habitat will be created by directly seeding onto bare ground after road projects are completed. We encourage this to be done in the early winter, or early spring, if possible, for the best, most forb-rich and diverse results. It is also possible to seed native forbs into existing grass-dominant rights of way (ROWs); however, some form of pre-treatment must occur to make these seedings successful (e.g., fire, selective herbicide, grazing). As this seems more difficult, if not impossible along roadways, we encourage pollinator habitat to be created from scratch. However, if the DOT desires to turn a grass-dominated ROW into pollinator habitat, please contact Lauren Sullivan and Sam Lord (see question 3 below).

3. *What seed mix should we use to create this pollinator habitat?*
    - Seed mixes should vary depending on the location of the project in order to promote local ecotypes, species appropriate to the area, and the degree of water-availability at each site. We have developed a relationship with Sam Lord with the Missouri DNR who is responsible for creating and monitoring many grassland restorations in the state parks of Missouri. He has offered to help create specialized seed mixes for new projects as they develop. Please contact Sam Lord at (Sam.Lord@dnr.mo.gov). Lauren Sullivan is also happy to help navigate these discussions if necessary (sullivanll@umsystem.edu)

4. *How and when should we mow this pollinator habitat **as it is establishing**?*
    - Because of initial weed pressure, we encourage new pollinator plantings to be mowed frequently in the first two years of establishment. This will reduce weed pressure and result in higher quality pollinator habitat. The first year a ROW is seeded, it is appropriate to mow 2-3 times per year, with the mower blades getting

increasingly higher off the ground as the season progresses (~4 inches in early spring, to ~8-12 inches by the fall) to avoid killing too many of the small, native perennials. In the second year, 1-3 mowings are appropriate depending on the weed pressure, and we encourage the increase in the mower blade height as the season progresses.

5. *How and when should we mow this pollinator habitat* ***after it is established****?*
    - This is an extremely important but understudied question. While some amount of mowing supports flower production, there is concern that frequent mowings throughout the year (especially in in the summer months of May-August) will decrease butterfly and moth abundance. However, there is not sufficient data to comment fully on mowing effects on pollinators. To support driver safety while at the same time promoting pollinator habitat given the small amount of data available, we suggest using a tiered (or mosaic in Figure 19) mowing structure where more frequent mowings occur directly next to the road, and fewer and fewer seasonal mowings occur as you move away from the road. We encourage future study of how management affects pollinator abundance and population dynamics.



(Phillips, Wallace et al. 2020)

Figure 19: Management recommendations from Phillips, Wallace et al. 2020 on how to manage ROWs for pollinator habitat. We encourage the tired or mosaic mowing strategy

6. *How can we quantify the ecological benefits of a pollinator program (e.g., plant and pollinator increases in diversity and abundance)?*
    - To quantify the ecological benefits of a pollinator program, including questions related to how creation of pollinator habitat and management regimes influence plant and pollinator diversity and abundances, we recommend a blocked experimental design, with appropriate pre-treatment controls. Then to sample for plant abundance, we suggest using long-term plant monitoring quadrats along transects. To sample for pollinator abundance, we suggest surveys that include sweep netting, bowl or pan traps, and visual observation surveys with camera traps to decrease pollinator death. If there is interest in examining pollinator habitat effects on pollinator life history stages (e.g., effects on eggs, larvae/caterpillars and adults) we suggest including these surveys on host plants for given pollinators of interest.

Based on the practitioner literature and the geospatial analysis of state ROWs, below we respond to the questions raised by MoDOT from subtask 2.2, 2.3 and 2.4.

1. *How wide should pollinator habitat be on ROWs?*
    - Based on the guidance from Ohio DOT (Ohio DOT and Davey Resource Group 2016),we suggest that a pollinator habitat should have a minimum width of at least 10 ft and minimum area of at least 0.5 acres. The ideal size for pollinator habitat on the ROW is at least 2 acres.

2. *What distance off the roadway should this pollinator habitat start?*
    - Based on practices on other DOTs, we suggest that the minimum offset from the roadway to the pollinator habitat should be at least 15 ft or the clear zone or obstruction free zone, whichever is greater. The desirable offset is 65 ft (Ohio DOT and Davey Resource Group 2016). These guidelines may be adjusted based on site-specific conditions, such as the presence of guardrail.

3. *Are there locations in Missouri that would be optimal for creating pollinator habitat?*
    - We encourage Missouri to collaborate with other states to contribute to the monarch highway along I-35.
    - Based on available geospatial information, we suggest a feasibility analysis that could be used to identify and quantify the extent of linear features along major highways. Such assessment will help identify how the ROWs can be used to establish connectivity between natural landscapes such as state parks and conservation areas.

4. *Are there guidelines from other state DOTs for vegetation management to promote*

pollinators?

- Various types of guidance regarding pollinators are available from other state DOTs. Colorado and Nebraska include some considerations for pollinators in their vegetation management guidelines (citations). A guidance document from Ohio provides direction for DOT staff for the development and maintenance of highway pollinator habitat within the ROW (Ohio DOT and Davey Resource Group 2016).

5. *How can we quantify the human benefits of a pollinator program (e.g., less mowing)?*
    - The economic benefits of less mowing could be quantified as an estimated reduction in mowing costs. A Mississippi DOT study estimated that the elimination of one mowing per year could lead to annual savings of approximately $8.7 million based on a mowing cost per acre of $250 (Guyton et al. 2014). Future field studies similar to the previously completed Maryland study (Kuder 2019) could look at impacts of a pollinator program on the abundance and diversity of pollinator species in Missouri.

6. CONCLUSIONS

Project Objectives, Scope, and Methodology

The project objectives are three-fold in nature:

1. Develop an understanding of the needs of the beneficial insects of interest (e.g., pollinators, natural enemies of crop pests), including the habitat requirements of these insects, the potential deleterious impacts of agricultural chemicals and roadway pollution, and the lessons learned in efforts to restore and to develop new pollinator habitat;
2. Understand the opportunities and limitations of developing pollinator habitat along roadsides and within rights of way (ROWs); and
3. Merge knowledge of highway design, operation and maintenance with pollinator habitat creation knowledge to answer the specific questions posed by MoDOT and to make initial recommendations where pollinator habitat efforts might prove to be productive.

Methods used to achieve the synthesis objectives included a review of academic, practitioner, and agricultural literature; survey questionnaire; DOT interviews; and GIS analysis. Various literature sources such as guides, research reports, journal articles, and DOT manuals were reviewed and compiled. An online survey questionnaire on DOT practices for promoting pollinator habitat was distributed to the DOTs for all 50 states and the District of Columbia. Survey responses were received from 46 DOTs for a response rate of 90%. Interviews were conducted with DOT personnel from Arkansas, Iowa, Minnesota, Virginia, and Washington. Available geospatial data were compiled and a preliminary analysis was conducted to identify/highlight opportunities to establish pollinator habitat along highway ROWs and to link them with natural areas.

Summary of Key Findings

Key study findings are described in the following sections.

Academic Research Studies

- Creating pollinator habitat along highway ROWs is an excellent way to increase the floral diversity and resources available for pollinators and there is overwhelming evidence that creating this habitat positively influences plants.
- Pollinator habitat should be established using a larger ratio of forbs to grasses to create a diverse plant system and to create more resources for pollinators (and driver interest).
- Pollinator habitat should be seeded in the late fall/winter or early spring for the highest success probability.
- Pollinators may or may not be isolated by roadways when there are pollinator habitats along both sides of them. In general, large-bodied insects such as butterflies and bumblebees can

fly high enough over traffic to not be killed, and also to not be isolated by the road. However, smaller bodied insects are often isolated by roads and do not cross them.
- Pollinators can have increased mortality from roadway traffic; however, this mortality often tends to occur at hotspots and thus mitigation measures should be taken.
- There is very little research on how management of ROWs influences pollinator densities, but it is encouraged to have a tiered, or mosaic mowing pattern where areas closest to the road are mowed more frequently, and mowing frequency decreases as you move away from the roadway – with 0-1 mowings/year occurring in the furthest area from the roadway. These sections should be mowed once every other year to prevent woody growth.

Practitioner Resources

- The following four products from a NCRHP study are freely provided to DOTs: Landscape Prioritization Model for Roadside Habitat for Monarchs, Rapid Assessment of Roadside Habitat for Monarchs protocol and tool, Roadside Monarch Habitat Calculator, and decision-support tools (Cariveau et al. 2020).
- Guides developed by the Ohio DOT and Pollinator Partnership include forms to assess the suitability of a particular site for pollinator habitat based on various factors such as cover and health of existing vegetation, mowing frequency, soil texture and pH, land use, site size, sunlight, water availability, and accessibility (Ohio DOT and Davey Resource Group 2016, Galea et al. 2016).
- Guidance regarding BMPs for pollinator habitat is available from FHWA (FHWA 2016, Hopwood et al. 2015b), the Pollinator Partnership (Galea et al. 2016), and various states, such as Colorado (Colorado DOT 2020b), Indiana (Jacquart et al. 2017a), Minnesota (Minnesota Department of Agriculture n.d.), and Ohio (Ohio DOT and Davey Resource Group 2016).
- Planting guides from states such as North Carolina (North Carolina DOT 2016) and Maine (McCargo 2018) provide direction regarding setbacks, landscaping layouts, and plant selection. Lists of suitable plants and their characteristics are available for several states, including Indiana (Jacquart et al. 2017b), Maine (McCargo 2018), North Carolina (North Carolina Botanical Garden 2019), and Ohio (Ohio DOT and Davey Resource Group 2016).
- Contact Sam Lord (Sam.Lord@dnr.mo.gov) with the Missouri DNR to get a customized seed mix for the region of interest.
- While the availability of research studies to evaluate the effectiveness of BMPs for roadside pollinators is very limited, a field study in Maryland found that selective herbicide use and an annual fall mow led to increases in floral diversity and bee population (Kuder 2019).
- FHWA's website on pollinators provides links to different types of resources, including legislation, policies and guidance, FHWA pollinator publications and webinars, pollinator-friendly practices, funding opportunities, and state DOT information (FHWA n.d.).

DOT Practices

- The most frequently utilized methods for promoting pollinator habitat in the highway ROW are planting native species that benefit pollinators, limiting the frequency of mowing, and vegetation management practices.
- DOTs perceive the designation of ROW on DOT facilities and reclassification of existing habitat as the most effective methods for promoting pollinator habitat.
- DOTs use a wide range of offsets from the edge of pavement to the pollinator habitat, with the clear zone width of obstruction free zone width most frequently used.
- Over half of the survey respondents indicated that their agency does not generally provide pollinator habitat in the median.
- In determining where to plant native pollinator habitat species within highway ROW, DOTs most frequently consider climate and existing vegetation.
- Milkweed and Black-eyed Susan are the most commonly utilized species for providing pollinator habitat within highway ROW.
- DOTs most frequently plant for pollinator habitat during fall and spring.
- DOTs use different seed mixes to promote pollinator habitat within the ROW. The makeup of these seed mixes can vary based on land use, purpose of the planting, and geographical location.
- Seed drilling is the method most often used by DOTs to plant pollinator habitat within highway ROW. Other deployed methods include broadcast seeder, hydroseeding, and native shrubs in containers.
- DOTs use various IRVM techniques to help promote pollinator habitat within the ROW, such as mowing practices, prescribed burning, herbicides, and biological controls for specific weeds.
- Some DOTs divide the ROW into sections with different vegetation management practices in each section.
- DOTs tend to mow the clear zone or obstruction free zone and medians 60 feet or less in width more frequently than other areas.
- There is a wide range of DOT practices regarding a final mow out at the end of the season, and DOT opinions regarding the effectiveness of a final mow out to promote spring growth of pollinator habitat are divided.
- Only 30% of responding DOTs use a central database to store information such as location, composition, and density regarding pollinator habitat within highway ROW, with several DOTs working towards implementation of this practice.
- Shortage of agency staff is the most commonly reported obstacle to promoting pollinator habitat within highway ROW.

GIS Analysis

- Existing natural lands such as state parks, conservation areas and agricultural lands and

management should be considered during the development phase.

- Buffer, network and connectivity analysis can reveal potential sites along ROWs that can directly connect with existing natural landscapes or can act as stepping stones.
- Geospatial analysis should include multiple biophysical properties of the landscape including topography, soils and land management (agriculture, urban, etc.).

Summary of Recommendations

- Pollinators should only be encouraged on the median when it is very large. Otherwise, pollinator habitat efforts should be placed along roadsides and not in the middle of roadways.
- The most successful pollinator habitat will be seeded onto bare ground after road projects are completed in the early winter, or early spring.
- Seed mixes should vary depending on the location of the project in order to promote local ecotypes, species appropriate to the area, and the degree of water-availability at each site. Please contact Sam Lord (Sam.Lord@dnr.mo.gov) for help creating these mixes.
- New pollinator plantings should be mowed frequently in the first two years of establishment. The first year a ROW is seeded, it is appropriate to mow 2-3 times per year, with the mower blades getting increasingly higher off the ground as the season progresses (~4 inches in early spring, to ~8-12 inches by the fall) to avoid killing too many of the small, native perennials. In the second year, 1-3 mowings are appropriate depending on the weed pressure, and we encourage the increase in the mower blade height as the season progresses.
- Pollinator plantings should be mowed 0-2 times per year. The best mowing plan is to have a tiered, or mosaic structure (Figure 19). This plan includes more frequent mowings directly next to the roadway, with decreased mowings/year as you move away from the roadway. All areas should be mowed once every other year to decrease tree growth.
- Participation in the Monarch Highway along 1-35 would be an excellent way to contribute to increased pollinator habitat and connectivity.
- There are several high-quality vegetation areas along roadsides that should be conserved (see Recommendations section for details).
- We suggest that a pollinator habitat should have a minimum width of at least 10 ft and minimum area of at least 0.5 acres, with an ideal size for pollinator habitat on the ROW of at least 2 acres.
- We suggest that the minimum offset from the roadway to the pollinator habitat should be at least 15 ft or the clear zone or obstruction free zone, whichever is greater.
- Various types of guidance regarding pollinators are available from other state DOTs, such as Colorado, Nebraska, and Ohio.
- The economic benefits of less mowing could be quantified as an estimated reduction in mowing costs.

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APPENDIX A. SURVEY QUESTIONNAIRE

MODOT PROJECT TR202104

POLLINATOR HABITAT WITHIN HIGHWAY RIGHT OF WAY

SURVEY

LETTER TO THE RESPONDENT

Dear Participant,

The Missouri Department of Transportation (MoDOT) is sponsoring a research study on Pollinator Habitat Along the Right of Way (ROW). The study is being performed by the University of Missouri. The objective of the research study is to review and document DOT practices for promoting pollinator habitats within highway ROW.

Your cooperation in completing this survey will help to ensure the success of this research study. This survey is being sent to one person from each state DOT. You have been identified as the appropriate person at your DOT to complete this survey. The survey link that you received is unique for your DOT. If it would be more appropriate for someone else at your DOT to take this survey, please forward the email with the survey link to them or send their name and email address to Henry Brown (brownhen@missouri.edu). Additional instructions are provided at the beginning of the survey. If you would like to download a PDF version of the survey for informational purposes, please click here.

Please complete this survey by February 26, 2021. The survey includes 16 questions, and we estimate that the survey will take approximately 15 to 30 minutes to complete, depending on the level of detail you provide in the comments. If you have any questions, please contact Henry Brown, at (573) 882-0832 or brownhen@missouri.edu. Any supporting materials may be sent by email to Henry or uploaded in lieu of providing URLs. Thank you for participating in this survey!

SURVEY INSTRUCTIONS

1. To begin the survey, click the forward arrow at the bottom of this page.
2. To view and print the entire survey for informational purposes, click on this survey link and download and print the document.
3. To save your partial answers and complete the survey later, close the survey. Answers are automatically saved upon closing the browser window. To return to the survey later, open the

original email from Henry Brown and click on the survey link.

4. To pass a partially completed survey to a colleague, close the survey and forward the original email from Henry Brown to a colleague. Note that only one person may work on the survey at a time; the survey response should only be active on one computer at a time.
5. To view and print your answers after completing the survey, submit the survey by clicking "Submit" on the final page. Download and print the PDF on the following page which contains a summary of your responses.
6. To submit the survey, click on "Submit" on the last page.

SURVEY TIPS

1. Survey navigation is conducted by selecting the forward and back arrows at the bottom of each page.
2. If you are unable to complete the survey, you can return to the survey at any time by reentering through the survey link.

QUESTIONS

Contact Information

Name _____
State _____
Job Title _____
Phone Number _____
Email Address _____

1. Which of the following methods does your agency use to promote pollinator habitat within the highway right of way (ROW)? Please select all that apply.

   - ☐ Vegetation management practices
   - ☐ Plant non-native flower species that benefit pollinators
   - ☐ Plant native species that benefit pollinators
   - ☐ Designate areas on the highway ROW or designate corridors for pollinator habitats
   - ☐ Designate ROW on DOT facilities (e.g. rest areas) to provide pollinator habitat
   - ☐ Reclassify existing habitat as pollinator habitat
   - ☐ Limit the frequency of mowing
   - ☐ Promote the use of selective herbicides
   - ☐ Train maintenance crews to recognize native plants and invasive weeds
   - ☐ Other (please describe) _____
   - ☐ My agency does not use any of these methods to promote pollinator habitat within the highway ROW

Comments:

_____

2. The list of methods (if any) that you selected from the previous question is shown below. On a scale of 1 to 5 (1 = Poor, 5 = Outstanding, 0 = No opinion), how would you rate the effectiveness of each of the following methods in promoting pollinator habitat within the highway ROW in your agency's jurisdiction? *(Display only methods selected in Question 1).*

Method	Rating
Vegetation management practices	
Plant non-native flower species that benefit pollinators	
Plant native species that benefit pollinators	
Designate areas on the highway ROW or designate corridors for pollinator habitats	
Designate ROW on DOT facilities (e.g. rest areas) to provide pollinator habitat	
Reclassify existing habitat as pollinator habitat	
Limit the frequency of mowing	
Promote the use of selective herbicides	
Train maintenance crews to recognize native plants and invasive weeds	
Other	

Comments:

3. What is the minimum offset from the edge of pavement to pollinator habitat used by your agency?

   - ☐ 10 ft
   - ☐ 20 ft
   - ☐ 30 ft
   - ☐ 40 ft or more
   - ☐ Clear zone width or obstruction free zone width
   - ☐ Other (please describe) _____

Comments:

_____

4. What is the minimum median width used by your agency to provide pollinator habitat in the median?

   - ☐ Less than 20 ft
   - ☐ 21 ft to 40 ft
   - ☐ 41 ft to 60 ft
   - ☐ 61 ft to 80 ft
   - ☐ 81 ft or more
   - ☐ My agency does not generally provide pollinator habitat in the median
   - ☐ Other (please describe) _____

Comments:

_____

5. How frequently does your agency consider each of the following factors when determining where to plant native pollinator habitat species within highway ROW?

Factor	Always	Almost Always	Sometimes	Rarely	Never
Availability of Native Plants	☐	☐	☐	☐	☐
Availability of Local Ecotypes	☐	☐	☐	☐	☐
Climate	☐	☐	☐	☐	☐
Ease of Access for Maintenance Personnel	☐	☐	☐	☐	☐
Lateral Offset from Roadway	☐	☐	☐	☐	☐
ROW Width	☐	☐	☐	☐	☐
Soil Conditions	☐	☐	☐	☐	☐
Traffic Volumes	☐	☐	☐	☐	☐
Type of Existing Vegetation	☐	☐	☐	☐	☐
Type of Terrain	☐	☐	☐	☐	☐
Other (Please describe) _____	☐	☐	☐	☐	☐

Comments:

_____

6. How strongly do you agree or disagree that the following concerns have hindered your agency's efforts to promote pollinator habitat within highway ROW?

Concern	Strongly Agree	Somewhat Agree	Neither Agree Nor Disagree	Somewhat Disagree	Strongly Disagree
Agency Understaffed	☐	☐	☐	☐	☐
Climate Conditions	☐	☐	☐	☐	☐
Cost Associated with Native Habitat Plantings	☐	☐	☐	☐	☐
Herbicide Use	☐	☐	☐	☐	☐
Lack of Agency Buy-In	☐	☐	☐	☐	☐
Lack of Available ROW	☐	☐	☐	☐	☐
Lack of Perceived Need	☐	☐	☐	☐	☐
Lack of Suitable Soil	☐	☐	☐	☐	☐
Mowing Practices	☐	☐	☐	☐	☐
Public Awareness	☐	☐	☐	☐	☐
Staff Awareness	☐	☐	☐	☐	☐
Other (Please describe) _____	☐	☐	☐	☐	☐

Comments:

_____

7. Which of the following plants does your agency use to provide pollinator habitat within the highway ROW? Please select all that apply.

   - ☐ Milkweed (Asclepias spp.)
   - ☐ Purple coneflower (Echinacea spp.)
   - ☐ Yellow coneflower (i.e. grayhead coneflower, prairie coneflower) (Ratibida pinnata)
   - ☐ Coreopsis species (Coreopsis spp.)
   - ☐ Blazing Star (Liatris spp.)
   - ☐ Black-eyed Susan (Rudbeckia hirta)
   - ☐ Brown-eyed Susan (Rudbeckia subtomentosa)
   - ☐ Native sunflowers (Helianthus spp.)
   - ☐ Purple or white prairie clover (Dalea purpurea or D. candida)
   - ☐ Bluestem (Schizachyrium scoparium or Andropogon gerardii)
   - ☐ Dropseed (Sporobolus spp.)
   - ☐ Indian Grass (Sorgastrum nutans)
   - ☐ Other (please describe) _____

Comments:

---

8. How frequently does your agency plant for native pollinator habitat within highway ROW during the following months?

Time Period	Always	Almost Always	Sometimes	Rarely	Never
January - March	☐	☐	☐	☐	☐
April - June	☐	☐	☐	☐	☐
July - September	☐	☐	☐	☐	☐
October - December	☐	☐	☐	☐	☐

Comments:

---

9. How frequently does your agency use the following methods to plant native pollinator habitat within the highway ROW?

Method	Always	Almost Always	Sometimes	Rarely	Never
Broadcast Seeder	☐	☐	☐	☐	☐
Seed Drill	☐	☐	☐	☐	☐
Other (Please describe) _____	☐	☐	☐	☐	☐

Comments:

---

10. How frequently does your agency mow the following areas?

Area	Once per Year	2-3 Times per Year	4 or more Times per Year	Never
Median (width 60 ft or less)	☐	☐	☐	☐
Median (width greater than 60 ft)	☐	☐	☐	☐
Clear Zone or Obstruction Free Zone	☐	☐	☐	☐
Area Outside Clear Zone or Obstruction Free Zone	☐	☐	☐	☐
Other (Please describe) _____	☐	☐	☐	☐

Comments:

---

11. Does your agency find it beneficial to do a final mow out to promote spring growth of pollinator habitat?

    ☐ Yes
    ☐ No
    ☐ No opinion

Comments:

---

12. When does your agency do a final mow out at the end of the season to promote spring growth of pollinator habitat?

    ☐ Late fall
    ☐ After first frost
    ☐ During winter months
    ☐ My agency does not typically do a mow out at the end of the season
    ☐ Other (please describe) _____

Comments:

---

13. Does your agency have a database for storing information (e.g. locations, composition, density) regarding pollinator habitat within highway ROW?

    ☐ Yes
    ☐ No

Comments:

---

14. Has your agency developed any of the following resources related to promoting pollinator habitat within highway ROW? Please select all that apply.

- ☐ Pollinator habitat policy
- ☐ Guidelines for vegetation management
- ☐ Mowing policy
- ☐ Selective herbicide use policy
- ☐ Evaluation studies or studies to look at economics or quantification of benefits
- ☐ Cost information
- ☐ Other (please describe) _____

If you selected any resources in Question 13, please provide URL(s) for resources in the box below, upload files, or email files to brownhen@missouri.edu:

_____

Comments:

_____

15. Would you be willing to participate in a follow-up interview to discuss in greater detail your agency's practices for promoting pollinator habitat within highway ROW?

- ☐ Yes
- ☐ No

Please provide any additional comments that you may have regarding the promotion of pollinator habitat within highway ROW.

_____

_____

_____

SUBMITTAL INSTRUCTIONS

To complete the survey and record your answers, please click the "Submit" button.

Please note that once you click the "Submit" button, you will not be able to modify your answers. To save your partial answers and complete the survey later, close the survey. Answers are automatically saved upon closing the browser window. To return to the survey later, open the

original email from Henry Brown and click on the survey link. To pass a partially completed survey to a colleague, close the survey and forward the original email from Henry Brown to a colleague. Note that only one person may work on the survey at a time; the survey response should only be active on one computer at a time. To review your answers before submitting, please select the forward and back arrows at the bottom of each page.

END OF SURVEY

Thank you for completing this survey. Your efforts are greatly appreciated. Your responses are very important, and your feedback is welcome. For your information, a copy of your responses is provided below. You may download your responses in pdf format using the "Download pdf" link shown below. If you have any questions or comments, please contact the principal investigator, Henry Brown:

Henry Brown, P.E.
E2509 Lafferre Hall
University of Missouri
Columbia, MO 65211
(573) 882-0832
brownhen@missouri.edu

Your responses have been recorded, and you may now close your browser.

APPENDIX B. LIST OF AGENCIES RESPONDING TO THE SURVEY

Table B-1. List of Departments of Transportation (DOTs) responding to the survey

Responding Agency	Respondent Title
Alabama Department of Transportation	Agronomist Manager
Arizona Department of Transportation	Roadside Resources Specialist/Biology Team
Arkansas State Highway and Transportation Department	Natural Resources Section Head
California Department of Transportation	Sr. Landscape Architect/ Office of Roadside Maintenance
Colorado Department of Transportation	State Maintenance Engineer
Connecticut Department of Transportation	Landscape Designer
Delaware Department of Transportation	Assistant Director of Statewide Support Services
Florida Department of Transportation	Roadway and Roadside Manager
Georgia Department of Transportation	Landscape Architect Manager
Idaho Transportation Department	Roadside Programs Administrator
Illinois Department of Transportation	Roadside Vegetation Management Specialist
Indiana Department of Transportation	Roadside Maintenance Specialist
Iowa Department of Transportation	Chief Landscape Architect
Kansas Department of Transportation	Director of Field Operations
Louisiana Department of Transportation and Development	Facility Project planner 5-B/Landscape Architect Chief
Maine Department of Transportation	Maine DOT Statewide Vegetation Technician
Maryland Department of Transportation State Highway Administration	Director, Office of Maintenance
Massachusetts Department of Transportation	Supervisor of Landscape Design
Michigan Department of Transportation	Roadside Operations Specialist
Minnesota Department of Transportation	Roadside Vegetation Management Unit Supervisor
Nebraska Department of Transportation	Biologist
New Hampshire Department of Transportation	Environmental Manager

Responding Agency	Respondent Title
New Jersey Department of Transportation	Assistant Commissioner
New Mexico Department of Transportation	Roadside Environment Design Section Manager
New York State Department of Transportation	Principal Landscape Architect
North Carolina Department of Transportation	Roadside Environmental Engineer
North Dakota Department of Transportation	Assistant Division Director - Maintenance
Ohio Department of Transportation	ODOT Pollinator Habitat Program Administrator
Oklahoma Department of Transportation	State Maintenance Engineer
Oregon Department of Transportation	Roadside Development Program Leader
Pennsylvania Department of Transportation	Chief, Roadside/Strategic Environmental Management Program
Rhode Island Department of Transportation	Supervising Landscape Architect
South Carolina Department of Transportation	State Vegetation Manager
South Dakota Department of Transportation	State Construction & Maintenance Engineer
Tennessee Department of Transportation	Director, Asset Management Division
Texas Department of Transportation	Vegetation Specialist
Utah Department of Transportation	Stormwater Program Manager
Vermont Agency of Transportation	Program Manager, Pollution Prevention & Compliance, Maintenance Bureau
Virginia Department of Transportation	Pollinator Habitat Coordinator
Washington State Department of Transportation	Fish and Wildlife Program Manager
West Virginia Department of Transportation	Director, Operations Division
Wisconsin Department of Transportation	Landscape Architect

APPENDIX C. SURVEY RESPONSES

Table C-1. Survey responses for question 1 (methods used to promote pollinator habitat within highway ROW)

Respondent	Vegetation management practices	Plant non-native flower species that benefit pollinators	Plant native species that benefit pollinators	Designate areas on the highway ROW or designate corridors for pollinator habitats	Designate ROW on DOT facilities (e.g. rest areas) to provide pollinator habitat	Reclassify existing habitat as pollinator habitat	Limit the frequency of mowing	Promote the use of selective herbicides	Train maintenance crews to recognize native plants and invasive weeds	Other (please describe)	My agency does not use any of these methods to promote pollinator habitat within the highway ROW
Alabama	Yes	-	-	Yes	-	-	-	-	-	-	-
Alaska	-	-	-	-	-	-	-	-	-	-	-
Arizona	Yes	-	Yes	-	-	-	Yes	Yes	Yes	Yes	-
Arkansas	Yes	Yes	Yes	Yes	-	Yes	Yes	Yes	Yes	-	-
California	Yes	Yes	Yes	-	-	-	Yes	Yes	Yes	-	-
Colorado	Yes	-	Yes	Yes	-	-	-	-	-	Yes	-
Connecticut	Yes	-	Yes	Yes	Yes	-	Yes	Yes	-	-	-
Delaware	Yes	-	Yes	Yes	Yes	-	Yes	-	-	-	-
District of Columbia	-	-	-	-	-	-	-	-	-	-	-
Florida	Yes	Yes	Yes	Yes	Yes	-	Yes	Yes	Yes	Yes	-
Georgia	Yes	Yes	Yes	Yes	Yes	-	Yes	-	-	-	-
Hawaii	-	-	-	-	-	-	-	-	-	-	-

Respondent	Vegetation management practices	Plant non-native flower species that benefit pollinators	Plant native species that benefit pollinators	Designate areas on the highway ROW or designate corridors for pollinator habitats	Designate ROW on DOT facilities (e.g. rest areas) to provide pollinator habitat	Reclassify existing habitat as pollinator habitat	Limit the frequency of mowing	Promote the use of selective herbicides	Train maintenance crews to recognize native plants and invasive weeds	Other (please describe)	My agency does not use any of these methods to promote pollinator habitat within the highway ROW
Idaho	Yes	-	Yes	-	Yes	-	Yes	Yes	Yes	-	-
Illinois	Yes	-	Yes	Yes	Yes	-	Yes	Yes	-	Yes	-
Indiana	Yes	-	Yes	Yes	-	-	Yes	Yes	Yes	-	-
Iowa	Yes	-	Yes	Yes	Yes	-	Yes	Yes	Yes	Yes	-
Kansas	-	-	Yes	Yes	Yes	-	Yes	Yes	-	-	-
Kentucky	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	-
Louisiana	Yes	-	Yes	Yes	Yes	-	Yes	Yes	Yes	-	-
Maine	Yes	-	Yes	-	-	-	Yes	Yes	Yes	-	-
Maryland	Yes	Yes	Yes	-	Yes	-	Yes	Yes	Yes	Yes	-
Massachusetts	-	Yes	Yes	-	-	-	Yes	-	-	-	-
Michigan	Yes	Yes	Yes	-	Yes	-	Yes	Yes	Yes	Yes	-
Minnesota	Yes	Yes	Yes	Yes	Yes	-	-	Yes	Yes	-	-
Mississippi	-	-	-	-	-	-	-	-	-	-	-
Missouri	-	-	-	-	-	-	-	-	-	-	-
Montana	-	-	-	-	-	-	-	-	-	-	-

Respondent	Vegetation management practices	Plant non-native flower species that benefit pollinators	Plant native species that benefit pollinators	Designate areas on the highway ROW or designate corridors for pollinator habitats	Designate ROW on DOT facilities (e.g. rest areas) to provide pollinator habitat	Reclassify existing habitat as pollinator habitat	Limit the frequency of mowing	Promote the use of selective herbicides	Train maintenance crews to recognize native plants and invasive weeds	Other (please describe)	My agency does not use any of these methods to promote pollinator habitat within the highway ROW
Nebraska	Yes	-	Yes	-	-	-	-	Yes	Yes	Yes	-
Nevada	-	-	-	-	-	-	-	-	-	-	-
New Hampshire	-	-	-	-	-	-	-	-	-	-	Yes
New Jersey	Yes	-	-	-	-	-	-	Yes	-	-	-
New Mexico	Yes	-	Yes	-	Yes	-	-	-	Yes	-	-
New York	Yes	-	Yes	Yes	Yes	-	Yes	Yes	Yes	Yes	-
North Carolina	-	Yes	Yes	Yes	Yes	-	Yes	-	-	-	-
North Dakota	Yes	-	-	-	-	-	Yes	Yes	Yes	-	-
Ohio	Yes	-	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	-
Oklahoma	Yes	-	Yes	Yes	Yes	Yes	Yes	Yes	Yes	-	-
Oregon	-	Yes	Yes	-	-	-	-	-	-	Yes	-
Pennsylvania	Yes	-	Yes	Yes	Yes	-	Yes	Yes	-	-	-
Rhode Island	-	-	Yes	Yes	-	-	-	-	-	Yes	-
South Carolina	Yes	-	-	Yes	-	Yes	Yes	Yes	-	-	-
South Dakota	-	-	Yes	-	Yes	-	Yes	Yes	-	Yes	-

Respondent	Vegetation management practices	Plant non-native flower species that benefit pollinators	Plant native species that benefit pollinators	Designate areas on the highway ROW or designate corridors for pollinator habitats	Designate ROW on DOT facilities (e.g. rest areas) to provide pollinator habitat	Reclassify existing habitat as pollinator habitat	Limit the frequency of mowing	Promote the use of selective herbicides	Train maintenance crews to recognize native plants and invasive weeds	Other (please describe)	My agency does not use any of these methods to promote pollinator habitat within the highway ROW
Tennessee	Yes	-	Yes	-	-	-	Yes	-	-	-	-
Texas	Yes	-	Yes	Yes	Yes	-	Yes	Yes	Yes	-	-
Utah	-	-	Yes	-	-	-	-	-	-	-	-
Vermont	Yes	-	Yes	-	-	-	Yes	-	-	-	-
Virginia	-	-	Yes	Yes	Yes	-	Yes	Yes	-	-	-
Washington	Yes	-	Yes	-	-	-	Yes	Yes	Yes	-	-
West Virginia	-	-	Yes	Yes	Yes	Yes	Yes	-	-	-	-
Wisconsin	Yes	-	Yes	-	Yes	Yes	Yes	Yes	-	Yes	-
Wyoming	-	-	-	-	-	-	-	-	-	-	-
Total Yes	33	11	38	24	24	7	33	29	21	15	1

Table C-2. Text responses for "Other" for question 1 (methods used to promote pollinator habitat within highway ROW)

Responses for "Other"
We promote the planting of natives to our counties and cities also by acquiring seed from our Living Roadway Trust Fund and the Iowa Tallgrass Prairie Center at the University of Northern Iowa.
We have hired a consultant to perform inspections of the sites to make recommendations on the maintenance of the sites.
Use native species that benefit pollinators on partnership projects
Our DOT is considering joining the Monarch CCAA.
We started baseline mapping of pollinator plants along I-76 to see what's out there.
Established protective areas along the ROW that benefit specialized pollinators and their endangered host plants.
Research and public outreach about pollinators on ROW.
Partner with other entities who developing pollinator habitat on their R/W, such as Columbia Gas Transmission, Kentucky Utilities, and the like.
Our DOT is in field trials on a post-construction native seed mix that meets EPA vegetative coverage requirements, filters and slows storm water, and has pollinator benefits.
Landscape design to promote establishment of pollinator habitat.
Our promotion of pollinator habitat is limited.
Work with partners and other state agencies.
We have pilot programs to study the effects of timing of mowing in addition to frequency.
Developing schedules to do mowing and herbicide activities when monarch butterflies are not present.
We are currently in the process of developing District specific IVM plans.

Table C-3. Comments for question 1 (methods used to promote pollinator habitat within highway ROW)

Comments
Some of these practices are utilized in geographic regions of our state and not necessarily statewide.
Our DOT has recently updated our mowing guidelines to include endangered species. This guidance does benefit pollinators.
At this time we are not planting pollinator plots along our highways but have 60 acres planted at our rest area sites on the eastern part of the state which is also the pathway for the migration of butterflies through the state. The reason we chose to put them at our rest area locations was so that we would have a better capability through a contractor to maintain and preserve them. We wanted to ensure we would have the best habitats possible. We really don't have that capability in the Right of Way (ROW) to keep them maintained. One reason they would be hard to maintain is the landowners by law have the right to mow and hay the highway ROW and we really don't have a way to prevent them from doing that. Another reason we keep the ditches and medians mowed is for snow purposes so the snow won't catch and drift which is a safety concern. It also gives the traveling public more time to react to animals.
Our DOT is just beginning to evaluate timing of our mowing and herbicide treatments and plans to modify our treatments and schedules in the near future.
Conservation Mowing techniques were introduced in 2020.
All of our proposed pollinator sites are within our ROW along our interstates or within rest areas.
A number of these activities occur on portions of our system and are not the case everywhere. Non-native flowers serve other functions & are not planted for pollinators (legumes provide nitrogen for new soils).
Our DOT updated our vegetation management guidelines in 2018 to include pollinator conservation considerations and we are working on adding additional measures to address monarch butterflies specifically.
We currently do not employ any methods to benefit pollinator habitat, although we are in the planning phases of developing some in the near future.
In 2019 to 2020, 78% of plant species installed by our DOT were native species (does not include Native Meadow Establishment or Turfgrass Establishment).
Some of these practices are currently under development, such as limiting mowing frequency in areas designated as pollinator habitat. Planting both native and non-native flower species is done as part of our wildflower program.
A lot of what our state does has been in place for some time. It's just taking on the new of "pollinators" instead of native plants.
Our state's legislature designated I-76 as the "Pollinator Highway" in 2017 or 18.
We hope to be designating more areas on the ROW for pollinator habitat as we further revise vegetation management guidelines to institutionalize this practice statewide. We have used selective herbicides to date to control invasive species and overall unwanted vegetation (along guiderails, e.g.) not primarily to create pollinator habitat. Regarding planting, we currently strive to use natives, however some seed mixes we have used over the years have included non-native flowers.

Comments
My organization usually includes between 10-20% of forbs into a seed schedule. I have gotten approval to develop a pollinator habitat at one of our rest areas along with a guide for the establishment and maintenance of pollinator habitats in our DOT's ROW and on our DOT's properties.

Table C-4. Survey responses for question 2 (effectiveness of methods to promote pollinator habitat within highway ROW, 1 = Poor, 5 = Outstanding, 0 = No Opinion)

Respondent	Vegetation management practices	Plant non-native flower species that benefit pollinators	Plant native species that benefit pollinators	Designate areas on the highway ROW or designate corridors for pollinator habitats	Designate ROW on DOT facilities (e.g. rest areas) to provide pollinator habitat	Reclassify existing habitat as pollinator habitat	Limit the frequency of mowing	Promote the use of selective herbicides	Train maintenance crews to recognize native plants and invasive weeds	Other (please describe)
Alabama	3	-	-	3	-	-	-	-	-	-
Alaska	-	-	-	-	-	-	-	-	-	-
Arizona	4	-	5	-	-	-	4	3	4	-
Arkansas	3	5	5	4	-	4	3	3	3	-
California	2	3	2	-	-	-	2	3	3	-
Colorado	4	-	5	4	-	-	-	-	-	3
Connecticut	4	-	3	3	3	-	4	4	-	-
Delaware	3	-	3	3	4	-	3	-	-	-
District of Columbia	-	-	-	-	-	-	-	-	-	-
Florida	4	4	3	2	0	-	5	5	0	5
Georgia	3	3	3	3	-	-	3	-	-	-
Hawaii	-	-	-	-	-	-	-	-	-	-

Respondent	Vegetation management practices	Plant non-native flower species that benefit pollinators	Plant native species that benefit pollinators	Designate areas on the highway ROW or designate corridors for pollinator habitats	Designate ROW on DOT facilities (e.g. rest areas) to provide pollinator habitat	Reclassify existing habitat as pollinator habitat	Limit the frequency of mowing	Promote the use of selective herbicides	Train maintenance crews to recognize native plants and invasive weeds	Other (please describe)
Idaho	4	-	4	-	3	-	3	4	4	-
Illinois	3	-	2	2	4	-	4	4	-	-
Indiana	5	-	2	4	-	-	2	5	1	-
Iowa	4	-	5	4	5	-	5	3	4	5
Kansas	-	-	5	4	5	-	5	4	-	-
Kentucky	4	3	4	4	5	4	4	4	3	5
Louisiana	4	-	5	4	4	-	4	4	4	-
Maine	3	-	2	-	-	-	3	3	2	-
Maryland	5	3	4	-	4	-	5	5	3	-
Massachusetts	-	3	4	-	-	-	2	-	-	-
Michigan	5	2	4	-	4	-	5	4	3	4
Minnesota	3	4	4	3	4	-	-	4	4	-
Mississippi	-	-	-	-	-	-	-	-	-	-
Missouri	-	-	-	-	-	-	-	-	-	-

Respondent	Vegetation management practices	Plant non-native flower species that benefit pollinators	Plant native species that benefit pollinators	Designate areas on the highway ROW or designate corridors for pollinator habitats	Designate ROW on DOT facilities (e.g. rest areas) to provide pollinator habitat	Reclassify existing habitat as pollinator habitat	Limit the frequency of mowing	Promote the use of selective herbicides	Train maintenance crews to recognize native plants and invasive weeds	Other (please describe)
Montana	-	-	-	-	-	-	-	-	-	-
Nebraska	2	-	3	-	-	-	-	2	2	-
Nevada	-	-	-	-	-	-	-	-	-	-
New Hampshire	-	-	-	-	-	-	-	-	-	-
New Jersey	2	-	-	-	-	-	-	1	-	-
New Mexico	4	-	5	-	5	-	-	-	3	-
New York	4	-	4	3	3	-	2	2	3	2
North Carolina	-	5	5	4	5	-	4	-	-	-
North Dakota	3	-	-	-	-	-	3	3	3	-
Ohio	4	-	5	5	5	5	5	3	2	-
Oklahoma	3	-	3	3	2	3	4	3	4	-
Oregon	-	1	2	-	-	-	-	-	-	1
Pennsylvania	-	-	3	2	4	-	-	2	-	-
Rhode Island	-	-	3	3	-	-	-	-	-	5

Respondent	Vegetation management practices	Plant non-native flower species that benefit pollinators	Plant native species that benefit pollinators	Designate areas on the highway ROW or designate corridors for pollinator habitats	Designate ROW on DOT facilities (e.g. rest areas) to provide pollinator habitat	Reclassify existing habitat as pollinator habitat	Limit the frequency of mowing	Promote the use of selective herbicides	Train maintenance crews to recognize native plants and invasive weeds	Other (please describe)
South Carolina	4	-		4	-	4	5	3	-	-
South Dakota		-	3	-	3	-	3	3	-	-
Tennessee	3	-	2	-	-	-	3	-	-	-
Texas	5	-	4	4	5	-	4	4	5	-
Utah		-	2	-	-	-	-	-	-	-
Vermont	4	-	4	-	-	-	4	-	-	-
Virginia	4	-	3	4	4	-	5	3	-	-
Washington	2	-	2	-	-	-	3	2	3	-
West Virginia	-	-		-	-	-	-	-	-	-
Wisconsin	3	-	2	-	4	4	4	3	-	5
Wyoming	-	-		-	-	-	-	-	-	-
Average*	3.5	3.3	3.5	3.4	4.0	4.0	3.7	3.3	3.2	3.9
Standard Deviation*	0.9	1.2	1.1	0.8	0.9	0.6	1.0	1.0	0.9	1.5
Number of Ratings*	35	11	40	23	21	6	31	29	20	9

* Excludes 0 (= No opinion)

Table C-5. Comments for question 2 (effectiveness of methods to promote pollinator habitat within highway ROW)

Comments
Our DOT has used all native seeding since the 1990s. The seed mixes have increased in diversity and number of species over time. Vegetation management practices help maintain the native cover over time.
Our DOT's Division of Maintenance completed an Integrated Roadside Vegetation Management Guideline Manual to communicate maintenance practices to internal and external stakeholders.
Our DOT has invested considerable resources and time in deciding whether to join the Monarch CCAA.
Has a big impact on certain species and a moderate benefit on common species.
I mention that we "designate areas", these are not areas that are signed as such but rather we use a zonal approach to our management so areas beyond the 30' "clear zone" are focused on managing against invasive species, thereby promoting native vegetation/pollinator/nectar habitats by default. We are only mowing 15' from edge of pavement and these areas are treated with a broadleaf herbicide to control all broadleaf plants within the first 30' from edge of pavement. Therefore, our mowing frequency is not viewed as impacting pollinator habitat directly.
It is difficult to say what the effectiveness is, since there is no data to confirm at this stage. Right of way at DOT facilities is very useful for educating the public, but I'm not sure how to quantify it for supporting pollinators otherwise.
On our rural interstate system, we "swath mow" (15 foot pass) during the growing season. Around November we do a final mowing cycle that includes a portion of the roadside usually back to the tree line or at least to the "clear zone" limit.
Planting natives we hope will be a 5 eventually, but there are challenges in establishment, education and outreach. While vegetation management practices are very effective where implemented, they have not yet been broadly implemented statewide. We haven't designated many areas to date but hope to with implementation of revised vegetation management guidelines. Although mowing frequency is limited, the timing is not necessarily such that it impacts pollinator habitat.
State spray crews avoid milkweed and native flowering plants/shrubs. They selectively target brush trees and invasive plants for most of their spraying. Hydroseeding with milkweed and various native wildflowers was started last season, results are yet to be (sic) evaluated.
Sufficient data is not available to fully measure the effectiveness of these practices.
The main thing we struggle with is the maintenance of keeping woody species in check with the natives. We have over 50,000 acres of our roadsides restored to natives, but the contract herbicide applicators are frequently caught either blanket spraying or target spraying some of our native plants. We really need to work more on the educational bit for those contractors and require that they have reviewed all of the native plants in our seed mix, so they aren't mistakenly targeting our pollinator species.
There are a few limited mowing initiatives across the state, but there is no agency policy for guidance with regards to maintenance practices for pollinator habitat.

Comments
This method is certainly effective but is only as sustainable as it is maintained. We have much room for improvement in our maintenance of pollinator habitats.
Too early to measure the effectiveness of changes mowing frequency.
We plant it and forget it. We have seen with the research that we have conducted that the forbs that we plant tend to succeed out after the first 5 years. This is an issue when we are looking at our program and the benefit that it has for pollinators. We mow quite a bit and none of it is pollinator related. We also have an issue with volunteer mowers/adjacent landowners as well as farming in the ROW. We promote the use of and application of selective herbicides, but we know that there are large areas that are being sprayed and this does impact the forb community. We do outreach with the state's County Weed Officials, but we need to do more pollinator related training and teach them why and how they need to be more selective or careful when using herbicides.
We are going into the 4th year of the pollinator plots at our rest areas on the eastern part of the state and they are really looking good.
We are starting our pollinator program in January 2022.
We currently do not employ any specific methods to promote pollinator habitat.
We don't have any data yet to how these methods work or their effectiveness to promote pollinators.
When there are partnerships, the other entity provides maintenance that is more likely to sustain the life span of the vegetation (i.e. mowing appropriately & at the proper time).

Table C-6. Survey responses for question 3 (minimum offset from edge of pavement to pollinator habitat)

Respondent	10 ft	20 ft	30 ft	40 ft or more	Clear zone width or obstruction free width	Other (please describe)
Alabama	-	-	-	-	Yes	-
Alaska	-	-	-	-	-	-
Arizona	-	-	-	-	-	Yes
Arkansas	Yes	-	-	-	-	-
California	Yes	-	-	-	-	-
Colorado	-	-	-	-	-	Yes
Connecticut	-	-	-	-	-	Yes
Delaware	Yes	-	-	-	-	-
District of Columbia	-	-	-	-	-	-
Florida	-	-	-	-	Yes	-
Georgia	-	-	-	-	-	Yes
Hawaii	-	-	-	-	-	-
Idaho	-	-	Yes	-	-	-
Illinois	-	-	Yes	-	-	-
Indiana	-	-	Yes	-	-	-
Iowa	Yes	-	-	-	-	-
Kansas	-	-	-	-	-	Yes
Kentucky	-	-	Yes	-	-	-
Louisiana	-	-	-	-	Yes	-
Maine	-	-	-	-	Yes	-
Maryland	Yes	-	-	-	-	-
Massachusetts	-	-	-	-	-	Yes

Respondent	10 ft	20 ft	30 ft	40 ft or more	Clear zone width or obstruction free width	Other (please describe)
Michigan	Yes	-	-	-	-	-
Minnesota	-	-	-	-	Yes	-
Mississippi	-	-	-	-	-	-
Missouri	-	-	-	-	-	-
Montana	-	Yes	-	-	-	-
Nebraska	-	-	-	-	-	Yes
Nevada	-	-	-	-	-	-
New Hampshire	-	-	-	-	-	Yes
New Jersey	-	-	-	-	Yes	-
New Mexico	Yes	-	-	-	-	-
New York	-	-	-	-	-	Yes
North Carolina	-	-	-	-	Yes	-
North Dakota	-	-	-	-	-	Yes
Ohio	-	-	-	-	-	Yes
Oklahoma	-	-	-	-	Yes	-
Oregon	-	-	-	-	Yes	-
Pennsylvania	-	-	-	-	Yes	-
Rhode Island	-	-	-	-	Yes	-
South Carolina	-	-	Yes	-	-	-
South Dakota	-	-	-	-	-	Yes
Tennessee	-	Yes	-	-	-	-
Texas	-	-	Yes	-	-	-
Utah	-	Yes	-	-	-	-
Vermont	-	-	-	-	Yes	-

Respondent	10 ft	20 ft	30 ft	40 ft or more	Clear zone width or obstruction free width	Other (please describe)
Virginia	-	-	-	-	-	Yes
Washington	-	-	-	-	Yes	-
West Virginia	-	-	-	-	Yes	-
Wisconsin	-	-	-	-	-	Yes
Wyoming	-	-	-	-	-	-
Total Yes	7	3	6	0	14	14

Table C-7. Text responses for "Other" for question 3 (minimum offset from edge of pavement to pollinator habitat)

Text Responses for "Other"
We do not have a minimum offset requirement.
We do not have this set up yet. Our type A high forb mix that we do plant is usually 16 or more feet off the edge.
15' is our typical minimum offset, the typical "single pass" mowing distance.
15 feet
You should be asking in 15' increments. A mow deck is 15' wide and we use this width as "zones". Zone 1 (0-15) and that would be the minimum, because it is mowed for safety.
15 feet
Don't really designate one
25' buffer around the whole plot
Our mowing guidelines allow for a 10' spring cut and 30' fall cut.
Our state's DOT mows 30 feet from edge of pavement and medians multiple times for safety. If a 2-lane has less than 30 feet, the entire row is mowed regularly.
Between 6 -7 feet and 15 feet
Currently we have set no minimum.
18 feet, 5 feet beyond ditch, 5 feet generally beyond guardrail (depends on type of guardrail).

Table C-8. Comments for question 3 (minimum offset from edge of pavement to pollinator habitat)

Comments
Broadleaf selective herbicides are utilized annually within the first 30' from edge of pavement.
Certainly varies based on clear zone width. We also mow as close to the right-or-way fence as possible in a rotational manner keeping 2/3's not mowed outside the clear zone in any given year.
Though we have some limited mowing areas, the remaining area is not technically a designated pollinator habitat. Typically, the regularly mowed edge is a mower width (8-10 ft)
We mow an 8 ft strip along non interstate roads once per year. We mow the interstate inslopes once or twice per year and the backslopes once.
These decisions are all contextual - for instance, where there is guiderail immediately adjacent to the edge of pavement, we might actively maintain less than 15' on a regular basis, resulting in natural growth - but this would be "inadvertently" beneficial to pollinators - it wouldn't be something we would "designate" for ourselves as areas regularly maintained specifically for pollinators.
We make a 15 foot wide cut just off the pavement where the vegetation begins. The offset to the pollinator habitat can vary a bit depending on the offset where the vegetation begins.
We typically have pollinator habitat on the non-road-side of the ditch bottom. Inslopes and ditch bottoms are usually very disturbed.
We use native seed mixes on all unengineered surfaces with the exception of some areas of the state where millings may be placed as edge-of-pavement build-up without seeding.
We would like to have it closer, but our current design practice doesn't allow it to be closer to pavement.
15 feet from edge of pavement are short statured mostly native grass plantings, outside of this area to edge of ROW, forbs are included.
Originally, we had a 25' buffer. We are controlling the invasive cool season grasses such as smooth Bromegrass in and adjacent to pollinator plots by planting a short warm mix grass.
Pollinator habitat can be found in turfgrass areas where wildflowers have taken root or in managed landscape beds. We would not select an area that close to the edge of pavement to perform seeding operations specifically for pollinator habitat.
15 feet is the default minimum offset from pavement, but the mowed edge may be as narrow as 6 or 7 feet. It depends on how wide the right of way is, where the ditch is located, and how much mowable area is present off the edge of pavement.

Table C-9. Survey responses for question 4 (minimum median width to provide pollinator habitat in the median)

Respondent	Less than 20 ft	21 ft to 40 ft	41 ft to 60 ft	61 ft to 80 ft	81 ft or more	My agency does not generally provide pollinator habitat in the median	Other (please describe)
Alabama	-	-	-	-	-	Yes	-
Alaska	-	-	-	-	-	-	-
Arizona	Yes	-	-	-	-	-	-
Arkansas	-	-	-	-	-	Yes	-
California	-	-	-	-	-	Yes	-
Colorado	-	-	-	-	-	-	Yes
Connecticut	-	-	-	Yes	-	-	-
Delaware	-	-	Yes	-	-	-	-
District of Columbia	-	-	-	-	-	-	-
Florida	-	-	-	-	-	-	Yes
Georgia	-	-	-	-	-	Yes	-
Hawaii	-	-	-	-	-	-	-
Idaho	-	-	-	-	-	Yes	-
Illinois	-	-	Yes	-	-	-	-
Indiana	-	-	-	Yes	-	-	-
Iowa	-	-	-	-	-	Yes	-
Kansas	-	-	-	-	-	Yes	-
Kentucky	-	-	-	-	-	Yes	-
Louisiana	-	-	-	-	-	Yes	-
Maine	-	Yes	-	-	-	-	-
Maryland	-	Yes	-	-	-	-	-
Massachusetts	-	-	-	-	-	-	Yes

Respondent	Less than 20 ft	21 ft to 40 ft	41 ft to 60 ft	61 ft to 80 ft	81 ft or more	My agency does not generally provide pollinator habitat in the median	Other (please describe)
Michigan	-	-	-	-	-	Yes	-
Minnesota	-	-	-	-	-	Yes	-
Mississippi	-	-	-	-	-	-	-
Missouri	-	-	-	-	-	-	-
Montana	-	-	-	-	-	Yes	-
Nebraska	-	-	-	-	-	Yes	-
Nevada	-	-	-	-	-	-	-
New Hampshire	-	-	-	-	-	Yes	-
New Jersey	-	-	-	-	-	Yes	-
New Mexico	-	-	-	-	-	Yes	-
New York	-	-	Yes	-	-	-	-
North Carolina	-	-	-	Yes	-	-	-
North Dakota	-	-	-	-	-	Yes	-
Ohio	-	-	-	-	-	Yes	-
Oklahoma	-	-	-	-	-	Yes	-
Oregon	-	-	-	-	-	-	Yes
Pennsylvania	-	-	-	-	-	Yes	-
Rhode Island	Yes	-	-	-	-	-	-
South Carolina	-	-	-	-	Yes	-	-
South Dakota	-	-	-	-	-	Yes	-
Tennessee	-	-	-	-	Yes	-	-
Texas	-	-	Yes	-	-	-	-
Utah	-	-	-	Yes	-	-	-
Vermont	-	-	-	-	-	-	Yes

Respondent	Less than 20 ft	21 ft to 40 ft	41 ft to 60 ft	61 ft to 80 ft	81 ft or more	My agency does not generally provide pollinator habitat in the median	Other (please describe)
Virginia	-	-	-	-	-	-	Yes
Washington	-	-	-	-	-	Yes	-
West Virginia	-	-	-	-	-	Yes	-
Wisconsin	-	-	-	-	-	Yes	-
Wyoming	-	-	-	-	-	-	-
Total Yes	2	2	4	4	2	24	6

Table C-10. Text responses for "Other" for question 4 (minimum median width to provide pollinator habitat in the median)

Text Responses for "Other"
Our Agency does not promote pollinator habitat in medians.
Clear Zone setbacks apply when medians are wide enough.
We have 1 pilot project underway, so there isn't rule of thumb yet.
Depends. We must have a 11-15 foot safety zone for traffic to pull into. Our Districts have the option of using whatever is left to plant Wildflowers.
Just depends on amount left between property limits and amount needed to mow for safety. Generally, this is only on Interstates and large Primaries where ROWs are wide enough.

Table C-11. Comments for question 4 (minimum median width to provide pollinator habitat in the median)

Comments
We use native seed mixes on all unengineered surfaces with the exception of some areas of the state where millings may be placed as edge-of-pavement build-up without seeding.
We do have some areas of the state that have very wide medians that are not mowed.
We establish habitat in some bi-furcated median areas.
We do not have designated pollinator sites on the roadside, but we do have vegetation zones that are managed as meadows. These areas are generally free of woody vegetation and are mowed infrequently therefore offering good pollinator habitat.
There is no policy in place. But there are urban areas that have been planted with native plants that are less than 20 feet.
There are some very wide median areas that we plan to designate for pollinator management mowing, but there is not a standard width median choice.
We are planning to use the roadsides more often than the medians.
Some older sections are 41-60ft.
Medians less than 60' in width are mowed full width. Medians greater than 60' are only mowed to a distance of 15' from edge of pavement, however, the first 30' from edge of pavement is treated with broadleaf selective herbicides on an annual basis.

Table C-12. Survey responses for question 5 (factors considered when determining where to plant native pollinator habitat species within highway ROW)

Respondent	Availability of Local Native Plants	Availability of Local Ecotypes	Climate	Ease of Access for Maintenance Personnel	Lateral Offset from Roadway	ROW Width	Soil Conditions	Traffic Volumes	Type of Existing Vegetation	Type of Terrain	Other (Please describe)
Alabama	1	1	1	1	1	1	1	1	1	1	1
Alaska	-	-	-	-	-	-	-	-	-	-	-
Arizona	5	2	5	3	1	1	5	1	1	1	-
Arkansas	2	2	5	4	5	5	4	2	5	4	-
California	5	3	5	5	5	5	3	2	5	5	3
Colorado	4	4	4	2	4	4	4	1	5	5	5
Connecticut	2	4	2	5	5	5	4	3	4	4	-
Delaware	5	1	5	5	5	5	5	5	3	3	-
District of Columbia	-	-	-	-	-	-	-	-	-	-	-
Florida	3	3	5	4	5	4	4	2	4	4	-
Georgia	4	3	4	4	4	4	4	3	4	4	-
Hawaii	-	-	-	-	-	-	-	-	-	-	-
Idaho	4	4	5	5	3	5	5	2	5	5	5
Illinois	3	2	3	4	4	4	3	4	-	4	-
Indiana	2	2	5	5	5	5	2	2	4	4	-

Respondent	Availability of Local Native Plants	Availability of Local Ecotypes	Climate	Ease of Access for Maintenance Personnel	Lateral Offset from Roadway	ROW Width	Soil Conditions	Traffic Volumes	Type of Existing Vegetation	Type of Terrain	Other (Please describe)
Iowa	5	5	5	5	5	5	5	3	5	5	-
Kansas	5	4	4	4	3	3	2	1	4	2	-
Kentucky	1	1	2	4	5	5	4	2	5	5	1
Louisiana	5	1	5	5	5	5	1	5	5	5	-
Maine	4	-	4	2	3	3	4	2	4	3	-
Maryland	4	2	4	5	5	5	5	3	5	4	5
Massachusetts	2	4	1	-	4	1	1	1	4	3	-
Michigan	4	4	5	3	4	3	4	2	4	4	-
Minnesota	5	5	5	3	3	4	3	2	4	4	-
Mississippi	-	-	-	-	-	-	-	-	-	-	-
Missouri	-	-	-	-	-	-	-	-	-	-	-
Montana	1	1	1	3	5	4	1	1	3	3	-
Nebraska	5	5	5	1	1	1	1	1	1	1	-
Nevada	-	-	-	-	-	-	-	-	-	-	-
New Hampshire	-	-	-	-	-	-	-	-	-	-	-
New Jersey	3	2	3	4	4	5	3	5	4	3	-
New Mexico	5	3	4	2	2	2	2	2	4	2	-

Respondent	Availability of Local Native Plants	Availability of Local Ecotypes	Climate	Ease of Access for Maintenance Personnel	Lateral Offset from Roadway	ROW Width	Soil Conditions	Traffic Volumes	Type of Existing Vegetation	Type of Terrain	Other (Please describe)
New York	4	3	5	4	5	5	4	3	4	5	-
North Carolina	4	4	5	4	4	4	5	3	4	5	-
North Dakota	-	-	-	-	-	-	-	-	-	-	-
Ohio	2	2	3	5	2	5	3	3	5	5	-
Oklahoma	3	3	3	4	5	5	3	3	4	4	-
Oregon	4	4	5	4	5	5	3	2	3	4	-
Pennsylvania	3	-	4	4	5	5	4	3	3	4	-
Rhode Island	3	3	5	3	4	2	3	1	4	4	-
South Carolina	-	-	-	-	-	-	-	-	-	-	-
South Dakota	5	3	5	2	1	1	5	1	4	5	-
Tennessee	3	1	1	3	3	3	2	2	2	2	-
Texas	5	5	5	4	4	4	5	4	5	4	-
Utah	4	4	5	3	3	3	3	1	2	3	5
Vermont	4	2	4	4	4	4	3	1	4	3	-
Virginia	4	3	5	5	5	5	3	5	5	5	-
Washington	5	5	5	4	4	5	5	2	5	5	-
West Virginia	3	-	-	3	5	5	5	4	3	4	-
Wisconsin	2	1	3	3	3	3	3	1	1	1	4

Respondent	Availability of Local Native Plants	Availability of Local Ecotypes	Climate	Ease of Access for Maintenance Personnel	Lateral Offset from Roadway	ROW Width	Soil Conditions	Traffic Volumes	Type of Existing Vegetation	Type of Terrain	Other (Please describe)
Wyoming	-	-	-	-	-	-	-	-	-	-	-
Average	3.6	2.9	4.0	3.7	3.9	3.9	3.4	2.4	3.8	3.7	3.6
Standard Deviation	1.3	1.3	1.3	1.1	1.3	1.4	1.3	1.3	1.2	1.3	1.8
Number of Responses	41	38	40	40	41	41	41	41	40	41	8

Note: 5 = Always, 4 = Almost Always, 3 = Sometimes, 2 = Rarely, 1 = Never

Table C-13. Text responses for "Other" for question 5 (factors considered when determining where to plant native pollinator habitat species within highway ROW)

Text Responses for "Other"
Generally, we are only planting new ROW into native vegetation and this is typical on the backslope of the ditch. Maintenance operations plant a few acres per year, but we don't go out of our way to devegetate an area to revegetate it with native vegetation. That is to say that we don't currently do a lot of pollinator planting. More was conducted in the early 2000s but focus on this activity has not been high priority, nor funded.
Our State's Regulations require Native plants.
Annual precipitation
Other Factors: Long term maintenance costs and sustainability. Appearance and perception of customers
Precipitation versus elevation: higher elevation = more developed natural topsoil
Usually dependent upon projects budgets and receptiveness
Permit requirements, cost, surrounding land use

Table C-14. Comments for question 5 (factors considered when determining where to plant native pollinator habitat species within highway ROW)

Comments
Soil conditions are considered for all post-construction seeding; soil tests are required to determine if amendments are needed prior to seeding. Soil testing isn't required for seeding done by our maintenance units as they are typically not working in soils that are as compacted and disturbed as post-construction sites.
Currently, our only native species plantings are occurring on the grounds of certain welcome centers and/or rest areas. This is a limited effort at this time.
We worked closely with Game Fish and Parks and NCRS and to come up with a seed mixture that has worked well in our state.
Most of these factors we consider highly important, so many should rate a "5" in that regard, but to date, we have not always been able to fully take them all into consideration in all cases, due to project schedule and other circumstances - for instance, designers rely on general knowledge about local soils rather than take detailed site-specific soil tests before specifying planting.
Our DOT is in the beginning stages of designating these locations.
Our agency does not currently have any initiatives to plant native pollinator habitat, unless required for a specific project based on agency review and comment.
Right now, our pollinator effort is planting type A high forb on construction projects. On average we plant around 500 acres per year. The plantings are done when the project allows for it. This usually means that it has a significant backslope that allows for this type of planting.
We are not planting for pollinator habitat.
All of our potential pollinator sites had soil testing done at university extension services.
Our DOT does not currently plant native pollinator habitat species within highway ROW.
We perform most of our habitat establishment through seeding of pollinator species.

Table C-15. Survey responses for question 6 (concerns that hinder agency efforts to promote pollinator habitat within highway ROW)

Respondent	Agency Understaffed	Climate Conditions	Cost Associated with Native Habitat Plantings	Herbicide Use	Lack of Agency Buy-In	Lack of Available ROW	Lack of Perceived Need	Lack of Suitable Soil	Mowing Practices	Public Awareness	Staff Awareness	Other (Please describe)
Alabama	4	3	4	3	5	3	4	3	3	3	4	-
Alaska	-	-	-	-	-	-	-	-	-	-	-	-
Arizona	5	3	4	4	2	1	2	3	4	4	5	-
Arkansas	4	2	2	2	4	2	2	2	2	4	4	-
California	5	1	4	3	4	1	4	5	4	3	3	5
Colorado	3	3	4	1	4	3	4	3	1	3	3	-
Connecticut	5	2	4	1	4	2	4	4	4	2	4	-
Delaware	4	2	2	2	3	4	3	3	3	2	3	-
District of Columbia	-	-	-	-	-	-	-	-	-	-	-	-
Florida	5	3	4	1	2	1	2	1	1	3	3	-
Georgia	3	3	4	4	3	3	3	3	4	4	4	-
Hawaii	-	-	-	-	-	-	-	-	-	-	-	-
Idaho	4	5	5	4	5	3	3	4	5	4	4	-
Illinois	5	3	4	3	4	1	4	3	4	1	4	-
Indiana	4	1	5	1	5	5	5	1	3	5	5	-
Iowa	4	4	2	4	2	1	1	1	2	1	1	-
Kansas	5	5	5	5	4	2	3	4	2	3	3	-
Kentucky	4	1	3	1	1	1	2	2	3	2	2	-
Louisiana	2	3	4	1	3	3	2	2	2	2	3	-
Maine	4	5	5	2	4	2	3	4	5	3	3	-
Maryland	2	2	4	2	3	2	4	4	4	4	4	-
Massachusetts	5	-	2	4	5	1	3	1	5	4	4	-
Michigan	4	1	4	2	4	1	4	1	1	2	3	-

Respondent	Agency Understaffed	Climate Conditions	Cost Associated with Native Habitat Plantings	Herbicide Use	Lack of Agency Buy-In	Lack of Available ROW	Lack of Perceived Need	Lack of Suitable Soil	Mowing Practices	Public Awareness	Staff Awareness	Other (Please describe)
Minnesota	4	3	4	2	4	2	4	3	3	2	4	5
Mississippi	-	-	-	-	-	-	-	-	-	-	-	-
Missouri	-	-	-	-	-	-	-	-	-	-	-	-
Montana	1	1	3	4	2	1	4	1	4	1	3	-
Nebraska	5	1	2	4	4	1	2	1	4	2	3	-
Nevada	-	-	-	-	-	-	-	-	-	-	-	-
New Hampshire	4	1	4	1	2	2	2	1	4	4	4	-
New Jersey	4	3	3	4	4	5	4	3	4	4	4	-
New Mexico	3	3	4	4	4	2	3	2	4	4	4	-
New York	5	3	4	2	4	5	2	2	4	3	3	-
North Carolina	4	2	2	2	2	2	3	2	2	2	2	-
North Dakota	3	3	3	3	3	3	3	3	3	3	3	-
Ohio	2	2	2	1	1	1	2	3	1	2	4	-
Oklahoma	4	2	2	1	1	1	2	3	2	2	4	-
Oregon	4	1	2	4	5	2	5	1	5	2	4	5
Pennsylvania	5	2	2	2	2	2	4	2	2	2	4	-
Rhode Island	4	1	4	4	5	2	5	3	5	4	5	-
South Carolina	4	1	5	3	5	1	4	1	4	4	5	-
South Dakota	2	2	4	4	2	4	3	2	5	3	3	-
Tennessee	2	2	2	2	4	1	4	2	4	4	4	-
Texas	3	2	2	2	3	2	3	3	3	3	3	-
Utah	4	3	3	5	4	1	4	4	5	2	3	-
Vermont	5	4	2	2	2	1	2	2	2	2	4	-
Virginia	5	3	5	3	2	5	4	2	4	5	4	-
Washington	4	4	3	2	4	2	4	2	2	2	2	-
West Virginia	-	-	-	-	-	-	-	-	-	-	-	-

Respondent	Agency Understaffed	Climate Conditions	Cost Associated with Native Habitat Plantings	Herbicide Use	Lack of Agency Buy-In	Lack of Available ROW	Lack of Perceived Need	Lack of Suitable Soil	Mowing Practices	Public Awareness	Staff Awareness	Other (Please describe)
Wisconsin	5	3	4	4	4	3	5	3	4	5	5	4
Wyoming	-	-	-	-	-	-	-	-	-	-	-	-
Average	3.9	2.5	3.4	2.7	3.3	2.2	3.3	2.4	3.3	2.9	3.6	4.8
Standard Deviation	1.1	1.2	1.1	1.2	1.2	1.3	1.0	1.1	1.2	1.1	0.9	0.5
Number of Responses	43	42	43	43	43	43	43	43	43	43	43	4

Note: 5 = Strongly Agree, 4 = Somewhat Agree, 3 = Neither Agree Nor Disagree, 2 = Somewhat Disagree, 1 = Strongly Disagree

Table C-16. Text responses for "Other" for question 6 (concerns that hinder agency efforts to promote pollinator habitat within highway ROW)

Text Responses for "Other"
State Governance does not consider pollinators a priority and their lack of priority trickles down.
Lack of establishment of plantings, lack of technical expertise at maintenance level, lack of resources directed at habitat maintenance at maintenance level
Fire prone regions
Mowing practices historically were a major hinderance. Current policy is limiting mowing width.
Our state's DOT works with counties to maintain roads. We do not have our own staff. This has challenges for implementation.
Our state is on the outskirts of Monarch migration, so understanding need is critical.

Table C-17. Comments for question 6 (concerns that hinder agency efforts to promote pollinator habitat within highway ROW)

Comments
Our DOT has been fairly open to adjusting mowing practices to support pollinator insects. Concern about public perceptions and communication seem to be the biggest hurdles.
Native plantings in the arid regions of our state require more maintenance and costs, reducing the feasibility of enhancing pollinator habitat.
We would benefit from creating a standard vegetation management training module that includes pollinator habitat considerations.
We wanted an area that was controlled where we would have the best chance at a successful pollinator plot that is why we chose our rest areas.
Leadership is supportive and discussions are currently ongoing in this area.
Public support has been a big factor in our continued pollinator work. We still receive comments about areas where we have changed mowing policy or are restoring habitat but typically once we share the story of monarchs and other pollinators, the message and work are received with enthusiasm and positive support.
As part of the capital development program, the agency often provides native planting that can benefit pollinators. The major challenge is the follow-up management after planting and seeding, and the necessary public information that needs to go with the meadow aesthetic characteristic of pollinator sites.
We perform most of our habitat establishment through seeding of pollinator species and not the installation of live plantings. We only do this at specific locations, such as rest areas.
Pollinator habitat is generally not an easy business for a ROW manager. The management is generally specialized in skill, materials, and equipment. Further, it is generally expensive and is not generally required and/or all that beneficial for meeting the requirements/needs/purpose of the ROW. To say this another way- the net benefit of converting/maintaining a diverse set of species as native pollinator habitat is very low to the agency as compared to a homogenous set of vegetation.
Our environmental/natural resources group is aware of the importance of supporting pollinators and wants to do more. Our maintenance division doesn't recognize the importance & is reluctant to change mowing schedules & patterns. If complaints come in regarding an intended meadow looking weedy or unkept, sometimes quick decisions are made to mow rather than explain to the public what the intent is.
Our agency is in the beginning phases of implementing pollinator habitat and it is too early to gauge these items.
We have just started the planning phases.

Table C-18. Survey responses for question 7 (plant species used for providing pollinator habitat within highway ROW)

Respondent	Milkweed (Asclepias spp.)	Purple coneflower (Echinacea spp.)	Yellow coneflower (i.e. grayhead coneflower, prairie coneflower) (Ratibida pinnata)	Coreopsis species (Coreopsis spp.)	Blazing Star (Liatris spp.)	Black-eyed Susan (Rudbeckia hirta)	Brown-eyed Susan (Rudbeckia subtomentosa)	Native sunflowers (Helianthus spp.)	Purple or white prairie clover (Dalea purpurea or D. candida)	Bluestem (Schizachyrium scoparium or Andropogon gerardii)	Dropseed (Sporobolus spp.)	Indian Grass (Sorgastrum nutans)	Other (Please describe)
Alabama	Yes	-	Yes	Yes	-	Yes	-	Yes	-	-	-	Yes	-
Alaska	-	-	-	-	-	-	-	-	-	-	-	-	-
Arizona	Yes	-	-	Yes	-	-	-	Yes	Yes	Yes	Yes	-	Yes
Arkansas	Yes	Yes	-	Yes	Yes	Yes	-	-	-	Yes	-	Yes	-
California	Yes	-	-	-	-	-	-	Yes	-	-	-	-	-
Colorado	Yes	-	-	-	-	-	-	Yes	-	-	-	-	Yes
Connecticut	Yes	Yes	-	Yes	-	Yes	-	-	-	Yes	-	Yes	-
Delaware	Yes	-	-	-	-	Yes	Yes	-	Yes	-	-	-	Yes
District of Columbia	-	-	-	-	-	-	-	-	-	-	-	-	-
Florida	-	-	Yes	Yes	Yes	Yes	-	-	-	-	-	-	Yes
Georgia	-	-	-	Yes	-	Yes	-	-	-	-	-	-	Yes

Respondent	Milkweed (Asclepias spp.)	Purple coneflower (Echinacea spp.)	Yellow coneflower (i.e. grayhead coneflower, prairie coneflower) (Ratibida pinnata)	Coreopsis species (Coreopsis spp.)	Blazing Star (Liatris spp.)	Black-eyed Susan (Rudbeckia hirta)	Brown-eyed Susan (Rudbeckia subtomentosa)	Native sunflowers (Helianthus spp.)	Purple or white prairie clover (Dalea purpurea or D. candida)	Bluestem (Schizachyrium scoparium or Andropogon gerardii)	Dropseed (Sporobolus spp.)	Indian Grass (Sorgastrum nutans)	Other (Please describe)
Hawaii	-	-	-	-	-	-	-	-	-	-	-	-	-
Idaho	Yes	Yes	-	-	-	-	-	Yes	Yes	-	Yes	Yes	Yes
Illinois	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Indiana	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Iowa	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Kansas	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	-
Kentucky	Yes	Yes	Yes	Yes	Yes	Yes	-	Yes	Yes	Yes	Yes	Yes	-
Louisiana	-	-	-	Yes	-	Yes	-	-	-	Yes	-	Yes	-
Maine	Yes	-	-	-	-	Yes	-	-	-	-	-	-	Yes
Maryland	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	-
Massachusetts	Yes	Yes	Yes	Yes	Yes	Yes	-	Yes	-	Yes	-	Yes	-
Michigan	Yes	Yes	-	Yes	-	Yes	-	Yes	-	Yes	-	-	-

Respondent	Milkweed (Asclepias spp.)	Purple coneflower (Echinacea spp.)	Yellow coneflower (i.e. grayhead coneflower, prairie coneflower) (Ratibida pinnata)	Coreopsis species (Coreopsis spp.)	Blazing Star (Liatris spp.)	Black-eyed Susan (Rudbeckia hirta)	Brown-eyed Susan (Rudbeckia subtomentosa)	Native sunflowers (Helianthus spp.)	Purple or white prairie clover (Dalea purpurea or D. candida)	Bluestem (Schizachyrium scoparium or Andropogon gerardii)	Dropseed (Sporobolus spp.)	Indian Grass (Sorgastrum nutans)	Other (Please describe)
Minnesota	Yes	Yes	Yes	Yes	Yes	Yes	-	Yes	Yes	Yes	Yes	Yes	-
Mississippi	-	-	-	-	-	-	-	-	-	-	-	-	-
Missouri	-	-	-	-	-	-	-	-	-	-	-	-	-
Montana	Yes	Yes	-	-	-	-	-	Yes	-	-	Yes	-	Yes
Nebraska	Yes	Yes	Yes	-	Yes	Yes	-	Yes	-	Yes	-	Yes	-
Nevada	-	-	-	-	-	-	-	-	-	-	-	-	-
New Hampshire	-	-	-	Yes	-	Yes	-	-	-	-	-	-	Yes
New Jersey	-	-	-	-	-	-	-	-	-	-	-	-	-
New Mexico	Yes	Yes	-	Yes	Yes	-	-	-	Yes	Yes	Yes	-	-
New York	Yes	Yes	Yes	Yes	Yes	Yes	-	-	Yes	Yes	Yes	Yes	Yes
North Carolina	Yes	Yes	-	Yes	Yes	Yes	-	Yes	-	Yes	-	Yes	-
North Dakota	-	-	-	-	-	-	-	-	-	-	-	-	-

Respondent	Milkweed (Asclepias spp.)	Purple coneflower (Echinacea spp.)	Yellow coneflower (i.e. grayhead coneflower, prairie coneflower) (Ratibida pinnata)	Coreopsis species (Coreopsis spp.)	Blazing Star (Liatris spp.)	Black-eyed Susan (Rudbeckia hirta)	Brown-eyed Susan (Rudbeckia subtomentosa)	Native sunflowers (Helianthus spp.)	Purple or white prairie clover (Dalea purpurea or D. candida)	Bluestem (Schizachyrium scoparium or Andropogon gerardii)	Dropseed (Sporobolus spp.)	Indian Grass (Sorgastrum nutans)	Other (Please describe)
Ohio	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	-	Yes	Yes	Yes	Yes
Oklahoma	Yes	Yes	Yes	Yes	Yes	Yes	-	Yes	-	Yes	Yes	Yes	Yes
Oregon	-	-	-	-	-	-	-	-	-	-	-	-	Yes
Pennsylvania	Yes	-	-	-	-	Yes	-	-	-	-	-	-	-
Rhode Island	Yes	Yes	-	Yes	-	Yes	-	-	-	Yes	-	Yes	-
South Carolina	-	-	-	-	-	-	-	-	-	-	-	-	Yes
South Dakota	Yes	Yes	Yes	Yes	Yes	Yes	-	Yes	Yes	Yes	-	-	-
Tennessee	-	-	-	-	-	-	-	-	-	-	-	-	-
Texas	Yes	Yes	Yes	Yes	-	Yes	-	-	-	-	Yes	-	-
Utah	Yes	-	-	-	-	-	-	Yes	-	-	Yes	Yes	Yes
Vermont	-	-	-	-	-	-	-	-	-	-	-	-	Yes
Virginia	Yes	-	-	-	-	Yes	-	-	-	Yes	Yes	Yes	Yes

Respondent	Milkweed (Asclepias spp.)	Purple coneflower (Echinacea spp.)	Yellow coneflower (i.e. grayhead coneflower, prairie coneflower) (Ratibida pinnata)	Coreopsis species (Coreopsis spp.)	Blazing Star (Liatris spp.)	Black-eyed Susan (Rudbeckia hirta)	Brown-eyed Susan (Rudbeckia subtomentosa)	Native sunflowers (Helianthus spp.)	Purple or white prairie clover (Dalea purpurea or D. candida)	Bluestem (Schizachyrium scoparium or Andropogon gerardii)	Dropseed (Sporobolus spp.)	Indian Grass (Sorgastrum nutans)	Other (Please describe)
Washington	-	-	-	-	-	-	-	-	-	-	-	-	Yes
West Virginia	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	-	-	-	Yes
Wisconsin	Yes	-	-	-	-	-	-	-	-	-	-	-	Yes
Wyoming	-	Yes	-	-	-	Yes	-	Yes	-	Yes	Yes	Yes	-
Total Yes	33	24	17	26	18	30	8	23	14	23	18	22	23

Table C-19. Text responses for "Other" for question 7 (plant species used for providing pollinator habitat within highway ROW)

Text Responses for "Other"
Whenever possible, we try to design site specific mixes and appropriate species of wildflowers and flowering shrubs. We eventually hope to focus on local ecotype, but we aren't quite there yet.
Our seed mixes usually contain 7 or so grasses and 30 or so forbs. We base them on their location in the state, based on climate zone, and topography.
Flax, variety of penstemon
Gaillardia pulchella, Monarda punctata, Mimosa strigillosa, Ipomopsis rubra, Rudbeckia mollis, Phlox drummondii
Chrysothamnus (Rabbit Brush) Ericameria nauseosa Solidago cnadensis (Canada golden rod) Euthamia Occidentalis (western golden top) Cleome lutea (Yellow spider flower) Cleame serrulata (Rocky Mtn Bee plant)
We are currently developing new seed mixes with pollinator friendly species for use on highway construction projects not as standalone pollinator planting projects. See attached seed specs.
Orange Coneflowers
New England Aster, Early Goldenrod.
Oxeye daisy, Birdsfoot trefoil
Switchgrass
Lupines, penstemons, globemallow, rabbitbrush, sagebrush, western yarrow, blue flax, hoary tansy aster, biscuitroot spp.
Our state's DOT seed mixes are designed based on 9 different biotic communities across the state, with a mix of 20-30 species depending on availability.
Species listed (other than milkweed) are not endemic to our state.
This can vary from project to project it's really hard to say.
Western Yarrow, Lewis Flax, Blanketflower, Rocky Mountain Beeplant and Wild Bergamot. Also lots of native grasses.
There are a number of other species that are utilized.
Indian blanket flower
Our state's DOT does not currently plant pollinator habitat species within highway ROW.

Text Responses for "Other"
Our state's DOT has a multiple award contract with more than 11 mixes designed for slopes, wet, dry, fire hazard, etc.
Cosmos bipinnatus and Cosmos sulphureus
Plants would vary depending on the location, mix of native grasses, nectar and milkweed. Right now, we are only actually planting at facilities such as safety rest areas and park and rides. We are doing some seeding.
Flowering shrubs
Bergamont (bee balm), Columbines, Daisies, Indian Paint Brush.

Table C-20. Comments for question 7 (plant species used for providing pollinator habitat within highway ROW)

Comments
These 4 wildflower seeds were added to our roadside grass mix and hydroseeded onto new bank construction last season; and the season before onto cut and cleared wooded areas of interstate ROW.
Our goal is to preserve areas of milkweed and use herbicides that do not harm it.
We have a seed mix list that I can send you that is broken down per ecoregion.
The Quantity Purchase Agreement has our currently available seed mixes for our maintenance staff and others to order. Our new construction seed mixes are put together by our contract designers, no standards are in place for these seed mixes.
Again, we don't plant, so I can't say we use these plants checked but they are present on our ROW's.
We follow closer to the state's native species for pollinators.
We have standard native seed specifications, but they are old and geared towards the Karner Blue Butterfly. We create pollinator mixes as needed at this point in time.
Legumes (Dalea) are avoided due to concerns that they draw grazing animals into the ROW.
We have a forbs and native grass seed mix we use.
Many of these species occur naturally in our DOT's right of way. Plantings are generally done as part of the wildflower program, not necessarily specifically for pollinator insects. Many of these species are in seed packets that our DOT hands out to promote the wildflower program.
Plantings are conducted by our Highway Beautification Office.
See the sample seeding specification linked in a previous response. Due to variation in precipitation year to year across our state, the mixes contain species that germinate under a variety of conditions. We expect it to take 3 or more years to see the full results of the seed mix.
These will be part of our seed mixes that a university is helping develop for the different regions of our state.
I have to stress that we do not have them in along our highways. If wanted, I could provide our seed mixture.

Table C-21. Survey responses for question 8 (time of year for planting for native pollinator habitat within highway ROW)

Respondent	January - March	April - June	July - September	October - December
Alabama	1	1	1	1
Alaska	-	-	-	-
Arizona	3	3	3	3
Arkansas	3	3	3	3
California	5	5	5	5
Colorado	2	2	2	2
Connecticut	1	3	3	2
Delaware	2	3	2	3
District of Columbia	-	-	-	-
Florida	2	1	2	4
Georgia	-	3	4	3
Hawaii	-	-	-	-
Idaho	2	5	2	4
Illinois	3	3	1	2
Indiana	1	3	3	1
Iowa	2	4	2	2
Kansas	-	-	-	-
Kentucky	1	3	4	4
Louisiana	2	1	1	4
Maine	1	3	2	3
Maryland	4	5	4	5
Massachusetts	-	-	-	-
Michigan	1	3	3	2
Minnesota	2	5	5	3

Respondent	January - March	April - June	July - September	October - December
Mississippi	-	-	-	-
Missouri	-	-	-	-
Montana	4	-	-	4
Nebraska	3	2	2	3
Nevada	-	-	-	-
New Hampshire	-	-	-	-
New Jersey	1	2	1	1
New Mexico	4	4	4	4
New York	1	3	2	3
North Carolina	2	5	4	4
North Dakota	-	-	-	-
Ohio	5	5	3	1
Oklahoma	1	3	3	2
Oregon	1	1	2	3
Pennsylvania	2	3	2	3
Rhode Island	1	3	3	1
South Carolina	1	1	1	1
South Dakota	1	4	1	3
Tennessee	-	-	-	-
Texas	5	5	3	5
Utah	3	2	3	5
Vermont	1	3	4	3
Virginia	-	4	-	4
Washington	2	3	3	4
West Virginia	-	-	-	-
Wisconsin	3	3	3	3
Wyoming	1	4	3	3

Respondent	January - March	April - June	July - September	October - December
Average	2.2	3.1	2.7	3.0
Standard Deviation	1.3	1.2	1.1	1.2
Number of Responses	37	38	37	39

Note: 5 = Always, 4 = Almost Always, 3 = Sometimes, 2 = Rarely, 1 = Never

Table C-22. Comments for question 8 (time of year for planting for native pollinator habitat within highway ROW)

Comments
The seed mixes are designed to be planted any time of the year. The hydromulch and tackifier layer is checked at 30 days post application; if it is intact, the work is accepted from the contractor and seeds germinate when substantial rainfall occurs. The timing of precipitation is unpredictable across our state, so this system was developed over time to achieve results while allowing construction contracts to be closed out.
Our DOT's seeding window is October through May 15th. We generally have good luck with fall dormant season seeding.
We will use plugs in demonstration gardens at or rest areas in mid-summer where groundskeepers can water the plants.
In some areas of our state the growing season is 365 days.
We haven't started our program yet but will hopefully be planting early spring 2022.
Plant seeds in the winter. Plant plugs in the spring.
This is hard to gauge because it happens at the project level. Guidance is given to plant in the October - December for native seed, but seeding happens at all times so projects can be closed. Decisions made on budgets and not nature.
Again, we are only planting at facilities.
Answers are based on the assumption that most, if not all of our landscape installations provide pollinator habitat. We generally plant and seed year-round except for July and if soil is frozen
We do not currently plant for pollinator habitat.
Our spring seeding window range from March - May and fall seeding window range from October-November.
Our state is covered in snow all winter along most roads.
This is the typical planting schedule for the wildflower program.
Typical plantings are in the fall.
We try our best to target optimum planting seasons - spring and early fall but construction schedules and other circumstances frequently push us out of optimum time frames.
Generally, our planting season is April-June and September-November.
These plantings are done as part of revegetating disturbed soils on highway projects and not as stand-alone pollinator planting projects.
Most planting that occurs within the ROW is growing season planting. There are limited amounts of dormant season planting that occurs.

Table C-23. Survey responses for question 9 (methods used to plant native pollinator habitat within highway ROW)

Respondent	Broadcast Seeder	Seed Drill	Other (Please describe)
Alabama	1	1	-
Alaska	-	-	-
Arizona	2	2	4
Arkansas	4	-	-
California	3	3	5
Colorado	1	4	3
Connecticut	1	3	-
Delaware	3	3	-
District of Columbia	-	-	-
Florida	2	4	-
Georgia	-	4	-
Hawaii	-	-	-
Idaho	4	4	4
Illinois	3	3	2
Indiana	3	4	-
Iowa	1	5	-
Kansas	3	3	-
Kentucky	1	4	-
Louisiana	3	3	-
Maine	3	1	4
Maryland	4	3	3
Massachusetts	3	-	4
Michigan	3	3	-
Minnesota	4	4	4

Respondent	Broadcast Seeder	Seed Drill	Other (Please describe)
Mississippi	-	-	-
Missouri	-	-	-
Montana	3	4	2
Nebraska	4	3	-
Nevada	-	-	-
New Hampshire	-	-	-
New Jersey	1	1	-
New Mexico	5	5	-
New York	2	3	3
North Carolina	3	4	3
North Dakota	-	-	-
Ohio	5	5	5
Oklahoma	4	2	-
Oregon	1	1	3
Pennsylvania	3	3	-
Rhode Island	3	3	
South Carolina	1	1	-
South Dakota	1	4	1
Tennessee	-	-	-
Texas	5	5	-
Utah	4	4	-
Vermont	4	1	-
Virginia	-	-	-
Washington	1	1	4
West Virginia	-	-	-
Wisconsin	4	2	-
Wyoming	3	4	-

Respondent	Broadcast Seeder	Seed Drill	Other (Please describe)
Average	2.8	3.1	3.4
Standard Deviation	1.3	1.3	1.1
Number of Responses	39	38	17

Note: 5 = Always, 4 = Almost Always, 3 = Sometimes, 2 = Rarely, 1 = Never

Table C-24. Text responses for "Other" for question 9 (methods used to plant native pollinator habitat within highway ROW)

Text Responses for "Other"
Plan the entire site or supplement with plugs.
Hydroseed
Hydroseeding
Almost always hydroseeding.
Plugs of native grasses for habitat
Hydroseeding
Hydroseeder
Hydroseed at end of project construction
Native shrubs are in containers.
Hydroseed
Digging holes for seed
See comment below:
Hand on test plots or beautification
Hydroseeding - sometimes with seeds and mulch and tackifier combined.
Tru Ax seeder
Contracted hydroseeder truck.

Table C-25. Comments for question 9 (methods used to plant native pollinator habitat within highway ROW)

Comments
Prefer drill seed but doesn't always get used due to slope and site conditions.
Currently we do not plant specifically for pollinator habitat.
Unsure as to seeding methods as the Pollinator Habitat Projects have always been planting plugs or containers.
It is usually up to the Contractor.
Drill seeders are hard to use on the areas we seed due to shape, size and topography.
When we start, I believe it will be a combo of both techniques.
Our designated pollinator sites (at facilities) were installed with container stock plant material. We also use perennial plugs in our SWM areas. Seeding operations are typically associated with meadow or turfgrass establishment.

Table C-26. Survey responses for question 10 (frequency of mowing by area)

Respondent	Median (width 60 ft or less)	Median (width greater than 60 ft)	Clear Zone or Obstruction Free Zone	Area Outside Clear Zone or Obstruction Free Zone	Other (Please describe)
Alabama	3	4	3	4	-
Alaska	-	-	-	-	-
Arizona	4	4	4	1	-
Arkansas	3	3	3	4	-
California	3	3	2	4	2
Colorado	3	4	3	-	-
Connecticut	3	4	3	1	-
Delaware	2	4	2	4	-
District of Columbia	-	-	-	-	-
Florida	-	-	-	-	4
Georgia	-	-	-	-	3
Hawaii	-	-	-	-	-
Idaho	4	1	3	4	-
Illinois	4	-	3	-	-
Indiana	3	1	-	1	-
Iowa	3	3	2	1	4
Kansas	3	3	3	-	4
Kentucky	3	3	3	3	-
Louisiana	2	2	2	2	-
Maine	3	4	3	4	-
Maryland	2	4	2	1	-
Massachusetts	3	3	3	3	3
Michigan	4	1	3	1	2
Minnesota	4	1	3	1	-
Mississippi	-	-	-	-	-

Respondent	Median (width 60 ft or less)	Median (width greater than 60 ft)	Clear Zone or Obstruction Free Zone	Area Outside Clear Zone or Obstruction Free Zone	Other (Please describe)
Missouri	-	-	-	-	-
Montana	3	3	3	1	4
Nebraska	2	2	2	4	-
Nevada	-	-	-	-	-
New Hampshire	4	4	4	-	-
New Jersey	2	2	2	2	-
New Mexico	3	3	3	1	-
New York	3	4	4	1	3
North Carolina	2	2	3	3	-
North Dakota	3	1	3	1	-
Ohio	2	2	2	4	-
Oklahoma	2	2	2	3	-
Oregon	3	3	3	3	-
Pennsylvania	3	3	3	3	-
Rhode Island	3	3	3	3	-
South Carolina	2	4	2	4	-
South Dakota	3	3	3	4	-
Tennessee	2	2	4	4	-
Texas	-	3	3	4	-
Utah	4	4	3	4	-
Vermont	3	4	3	4	-
Virginia	3	3	3	4	4
Washington	4	4	4	1	-
West Virginia	2	2	2	4	-
Wisconsin	4	4	-	1	2
Wyoming	1	1	1	1	-
Average	2.9	2.9	2.8	2.6	3.2

Respondent	Median (width 60 ft or less)	Median (width greater than 60 ft)	Clear Zone or Obstruction Free Zone	Area Outside Clear Zone or Obstruction Free Zone	Other (Please describe)
Standard Deviation	0.8	1.0	0.7	1.3	0.9
Number of Responses	42	42	41	39	11

Note: 4 = Once per Year, 3 = 2-3 Times per Year, 2 = 4 or more Times per Year, 1 = Never

Table C-27. Text responses for "Other" for question 10 (frequency of mowing by area)

Text Responses for "Other"
Safety mowing such as vision corners and curves - as often as needed
High fire zones
Our state's DOT allows urban area backslopes to be mowed multiple times per year.
All mowable areas (less than 3:1 slope) are mowed on regular cycles. Certain routes are being designated for Pollinator Management Mowing, which will be done 1 - 2 times per year.
Areas needing additional weed control
I am not in the Maintenance business line and may not be correct.
Outside clear zone it is important to mow every 3-5 years to keep woody growth from establishing and causing damage to mowers.
Areas within the federal urban area boundaries are mowed more frequently than the rural areas.
We mow out 1/4 of our R/W each year.
Some areas in more urban locations are mowed in its entirety with every mow cycle. Likewise, some medians and clear zones are mowed more than 3 times a year, depending on the location.
Periodically the garages will mow a percentage of the native plantings to help control woody vegetation.
Single pass mowing (15') of the clear zone
Median <60: Urban interstate= 5 times Rural interstate= 3 times Other (US and State Routes) = 2 times. Median >60- we mow the first 15' only for the number of cycles above. Clear Zone (we only mow to 15' except for sight distance tapers): Same cycle frequency above Beyond Clear Zone: rare or only as part of a specific vegetation plan.

Table C-28. Comments for question 10 (frequency of mowing by area)

Comments
The frequencies vary greatly across the state. Typically, only one to two mower swath widths are mowed on the shoulder and wider medians annually. Areas beyond that may be mowed every 3 or longer or not at all. Sometimes a swath is mowed along the fence line if helpful for annual fence inspections.
Mowing widths are generally 8 to 10 feet from paved shoulder except for some medians.
The mowing schedule varies by district and rotation schedule (i.e. every other year, every 3 years, etc.).
We make one 10' pass in the spring on all shoulders and two 15' passes in the fall on all shoulders. We mow out the typical median spring and fall. We do not mow steep back slopes and interchange diamonds and leave these areas and areas along fences for potential pollinator habitat.
Some areas outside clear zone would never get mowed.
Mowing frequency is highly dependent on area of the state, urban vs rural, number of lanes, and speed limit.
We currently mow 1/year and on a as needed basis to address safety concerns. Frequency varies throughout state.
We maintain a 15ft safety strip along roadways and medians, along with any other necessary site lines. However, everything else is set up on a 3-year rotation unless as specific issue is being addressed. This will change as Districts work through their IVM plans and have each route planned out for the next 3 years.
Median widths 60 feet or less will be completely mowed each cycle during the year. Median widths exceeding 60 feet will be mowed with one or two passes or perhaps further out as directed by field supervisors.
We mow a 2-pass swath of 15 feet in the late spring/early summer, then a full mowing of all inslopes, backslopes and median areas late summer/ early fall.
Normally, we do not mow past the area designated to be kept in a cleared condition. In wide medians, we might mow the very center less frequently than the outer margins (the 15' single pass mowing zones).
Mowing is actually way more complex than this table allows. We have Urban and Rural mowing. And different kinds with each of those. A few notes are: safety mowing such as vision corners and curves, mow as often as needed. Clear zone mowing happens every three years. This all per policy, sometimes policy isn't followed.
My answers reflect the divided expressways. We have different mowing cycles for 2 and 1 lane roads.
NOTE: Areas outside clear zone are mowed on a rotational basis such that 2/3's of that area is not mowed annually. Clear zones in more urban contexts are mowed multiple times per year while clear zones in rural settings are mowed once per year.
Only mow to meet safety requirement. Other staff perception may be issues with fire protection or the public perception of "weeds".
We typically mow the R/W three times per year. The first mowing cycle is limited to one 15-foor pass, while the other two mowing cycles are full mowings to the fence or designated limit at specific times.
Pollinator plots are not in our ditches.

Table C-29. Survey responses for question 11 (perception of whether final mow out to promote spring growth of pollinator habitat is beneficial)

Respondent	Response Text
Alabama	No Opinion
Alaska	-
Arizona	No Opinion
Arkansas	Yes
California	No Opinion
Colorado	No Opinion
Connecticut	Yes
Delaware	Yes
District of Columbia	-
Florida	No Opinion
Georgia	No Opinion
Hawaii	-
Idaho	No Opinion
Illinois	No
Indiana	No Opinion
Iowa	No
Kansas	No
Kentucky	Yes
Louisiana	No
Maine	No
Maryland	Yes
Massachusetts	No
Michigan	No Opinion
Minnesota	Yes
Mississippi	-
Missouri	-
Montana	No Opinion
Nebraska	No Opinion
Nevada	-

Respondent	Response Text
New Hampshire	No Opinion
New Jersey	No Opinion
New Mexico	No Opinion
New York	No
North Carolina	Yes
North Dakota	No Opinion
Ohio	No
Oklahoma	Yes
Oregon	No
Pennsylvania	Yes
Rhode Island	No Opinion
South Carolina	Yes
South Dakota	Yes
Tennessee	Yes
Texas	Yes
Utah	No
Vermont	No Opinion
Virginia	No Opinion
Washington	No Opinion
West Virginia	-
Wisconsin	No
Wyoming	No
Total Yes	13
Total No	12
Total No Opinion	19
Total No Response*	2

* Based on 46 survey respondents

Table C-30. Comments for question 11 (perception of whether final mow out to promote spring growth of pollinator habitat is beneficial)

Comments
For turfgrass, our DOT does a final mow at the end of the season, but not expressly to promote spring growth. If anything, we seek to inhibit early spring growth in turfgrass areas. Several of our areas apply growth inhibitors in the fall and/or early spring. In our meadow vegetative zones, we do find that a final mowing in late fall/early winter does promote spring growth of pollinator habitat.
We haven't started our program at this time.
Right now, the main departmental reason for the final mow is mainly to prevent woody species, but there is more interest for its importance also to provide pollinator habitat. Our DOT has recently signed onto the monarch CCAA and so this is becoming more standard procedure.
We may mow more in snow drifting areas for winter safety.
Our mowing recommendations/timing vary across the state. See our DOT's Roadside Vegetation Management Guidelines for the recommended mowing times by biotic community. We are continuing to refine them and develop mowing schedules for each district.
I don't have any information or know if it is beneficial to do a final mow/cut.
In discussions of pollinator habitat, it has been said that annual mowing is detrimental to our state's native wildflowers, there have been proposals to eliminate backslope mowing or reduce it to every other year. I don't believe that idea has been implemented and may not be.
We do not do this nor have we discussed it.
Maintenance crews mow to maintain safety guidelines rather than to encourage vegetative growth.
No data to judge this, as these mowing schedules are new.
Theoretically, creating shorter residual vegetation in the fall will promote all broadleaf plants (both good and bad species!) that have a rosette/overwintering vegetative stage. However, residual vegetative debris (especially standing hollow stems) is used by many insect species for egg/larva overwintering therefore "mow outs" would be detrimental to those species.
Sometimes depending on location. This late mowing is more to control blowing and drifting snow and brush control than spring growth.
Typically, we use flail mowers to knock them down in the spring.
We do on our designated suitable habitat (80,000 acres) but not our high-value pollinator habitats. Those sites are mowed the first week of July and the first week of August for two years after planting begins.
Yes to the above but it also helps control "woody" growth.
We do not do final mow out.

Table C-31. Survey responses for question 12 (timing of final mow out to promote spring growth of pollinator habitat)

Respondent	Late fall	After first frost	During winter months	My agency does not typically do a mow at the end of the season	Other (please describe)
Alabama	-	-	-	-	-
Alaska	-	-	-	-	-
Arizona	-	-	-	-	Yes
Arkansas	Yes	-	-	-	-
California	-	-	-	Yes	-
Colorado	-	-	-	-	Yes
Connecticut	Yes	-	-	-	-
Delaware	-	-	-	-	Yes
District of Columbia	-	-	-	-	-
Florida	Yes	-	-	-	-
Georgia	-	-	Yes	-	-
Hawaii	-	-	-	-	-
Idaho	-	-	-	-	Yes
Illinois	Yes	-	-	-	-
Indiana	-	-	-	-	Yes
Iowa	-	-	-	Yes	-
Kansas	-	-	-	Yes	-
Kentucky	-	Yes	-	-	-
Louisiana	-	-	-	Yes	-
Maine	-	-	-	-	Yes
Maryland	Yes	-	-	-	-

Respondent	Late fall	After first frost	During winter months	My agency does not typically do a mow at the end of the season	Other (please describe)
Massachusetts	Yes	-	-	-	-
Michigan	-	-	-	Yes	-
Minnesota	-	-	-	-	Yes
Mississippi	-	-	-	-	-
Missouri	-	-	-	-	-
Montana	-	-	-	-	Yes
Nebraska	-	-	-	-	Yes
Nevada	-	-	-	-	-
New Hampshire	Yes	-	-	-	-
New Jersey	Yes	-	-	-	-
New Mexico	-	-	-	Yes	-
New York	-	-	-	Yes	-
North Carolina	-	-	Yes	-	-
North Dakota	-	-	-	Yes	-
Ohio	-	-	-	-	Yes
Oklahoma	Yes	-	-	-	-
Oregon	-	-	-	Yes	-
Pennsylvania	-	Yes	-	-	-
Rhode Island	-	-	-	Yes	-
South Carolina	Yes	-	-	-	-
South Dakota	-	-	-	Yes	-
Tennessee	Yes	-	-	-	-
Texas	Yes	-	-	-	-

Respondent	Late fall	After first frost	During winter months	My agency does not typically do a mow at the end of the season	Other (please describe)
Utah	-	-	-	Yes	-
Vermont	-	-	-	Yes	-
Virginia	-	-	-	-	Yes
Washington	Yes	-	-	-	-
West Virginia	-	Yes	-	-	-
Wisconsin	-	-	-	Yes	-
Wyoming	-	-	-	-	Yes
Total Yes	13	3	2	14	12

Table C-32. Text responses for "Other" for question 12 (timing of final mow out to promote spring growth of pollinator habitat)

Text Responses for "Other"
We mow out but for snow in some areas.
This is a loaded question. We mow for blowing snow issues not for pollinator seeding.
Plants are generally dormant in early fall. Mowing is done primarily to prevent snow drifting.
1st cut of the spring
The timing varies across the state and not all areas do a final mow out.
Late fall and winter depending on snow depth.
Interstate 70 is the dividing line. North of I-70 final mowback begins after October 1. South of I-70 final mowback begins October 15.
Oct 15-Nov 1. Ideally Nov 1 or later but some areas need to mow earlier to prepare for snow removal. A couple districts are doing earlier and we are working with them to delay their mowing until Oct 15th or later.
Final full mow starts early August and goes into Sept. in places.
Why are mow outs conducted in the first place? In fire prone areas, I understand this practice is to enable the road to serve as a firebreak... otherwise, reasons may include annual biomass reduction of woody vegetation (not effective to control the target!), spreading of seeds (both good and bad!), and potentially reduced snow lodging effects thereby allowing snow to move more freely within the ROW?
I do not know if our districts do a final mow out. I know some districts mow specific highways late fall to reduce snow drifting on roadways but do not know if it helps promote spring growth.

Table C-33. Comments for question 12 (timing of final mow out to promote spring growth of pollinator habitat)

Comments
Our plan is to mow after the first hard frost.
We do a clean-up mowing, but I could not say it is to promote pollinator habitat.
In locations where we still do a mow out, it is in late fall. However, it does not promote spring growth of pollinator habitat.
For limited mow areas, we typically do a spring cut because fall cut is frequently too early (before seed dispersal).
Late summer mowing can spark fires. Mowing during wet season results in rutting.
Areas designated for Pollinator Management Mowing will be mowed on the regular mowing cycles to 15 feet off the edge of pavement (6-7 feet for narrow/steep rights of way). The entire mowable right of way area will be cut back between November and March, with mowing height between 8 and 12 inches. There is a cut back option in July and early August as well, but that is only when needed.
Typically mow in summer months and into early fall, although schedule does not currently relate to benefits to pollinators.
Farmers are allowed to take the hay. This is typically done in areas that are not mowed except for steep slopes.
Timing of a final clean up mowing will vary depending upon weather conditions. Generally, late October or early November; however, the goal of end of season mowing of turfgrass areas is not to promote spring growth, but to maintain clear zones.
I think the final full mow is intended to accomplish goals other than pollinator habitat improvement. Those could include animal visibility, brush suppression, and fire hazard reduction. If native nectar source annuals have gone to seed by then, they should be relatively unaffected by this. If not, they will have difficulty surviving and spreading.
See comments above regarding the Roadside Vegetation Management Guidelines.

Table C-34. Survey responses for question 13 (use of a database to store information for pollinator habitat within highway ROW)

Respondent	Response Text
Alabama	No
Alaska	-
Arizona	No
Arkansas	No
California	No
Colorado	Yes
Connecticut	Yes
Delaware	Yes
District of Columbia	-
Florida	No
Georgia	No
Hawaii	-
Idaho	No
Illinois	No
Indiana	No
Iowa	Yes
Kansas	No
Kentucky	Yes
Louisiana	No
Maine	Yes
Maryland	Yes
Massachusetts	No
Michigan	No
Minnesota	No
Mississippi	-
Missouri	-
Montana	No
Nebraska	Yes
Nevada	No

Respondent	Response Text
New Hampshire	No
New Jersey	No
New Mexico	No
New York	No
North Carolina	Yes
North Dakota	No
Ohio	Yes
Oklahoma	Yes
Oregon	No
Pennsylvania	No
Rhode Island	No
South Carolina	No
South Dakota	No
Tennessee	No
Texas	Yes
Utah	No
Vermont	Yes
Virginia	No
Washington	No
West Virginia	No
Wisconsin	No
Wyoming	Yes
Total Yes	14
Total No	32
Total No Response*	0

* Based on 46 survey respondents

Table C-35. Comments for question 13 (use of a database to store information for pollinator habitat within highway ROW)

Comments
Hopefully soon we will be a part of the ROW as Habitat Geospatial Database, as part of our membership with the Monarch CCAA
ArcGIS map in progress.
We are in the process of developing one, but nothing to share at this time.
Consultant produces a monthly report on how the pollinator plots are doing. He does a Floristic Quality Indicator (FQI) for each site.
Our DOT has an inventory of designated pollinator sites in select facilities. Since we do not have designated pollinator sites along our roadsides, we do not have an inventory in these areas; however, we have mapped our Meadow Vegetative zones in many areas along our roadsides.
Nothing currently but it is a work in progress.
We will have bi-annual reports that will be sent to the USFWS for our 7a1 Pollinator mitigation agreement with them. This will include locations, acreage, and how the plots are doing and if remediation is needed.
We currently do not have Right of Way data across the state in a digital format nor do we have a vegetation/habitat layer or database statewide.
Currently in the process of creating.
Building one under our Monarch CCAA (ROW Habitat Spatial Database) and our DOT's MATS.
Not at the present time, but we are working on developing methods to store and manage information including "Collector Apps."
Private citizens and non-profits have applied for special use permits to establish pollinator habitat in ROW.
We are working to develop mapping, but for now there is no existing database for this.
As part of the Monarch Butterfly Candidate Conservation Agreement with Assurances, our DOT, and/or its contractor, will be forced to developing/maintain a habitat monitoring database for this purpose.
C-plan mapping data at HQ GIS unit.
We just developed a database this past year and are still refining it. It encompasses reclamation as a whole.
It is in the beginning stages. We have enrolled in the CCAA agreement and have random site surveys for Monarch habitat taken in 2019 by interns catalogued. We just started hydroseeding open ground areas with 4 native pollinator friendly wildflower seeds added to our roadside grass mix in 2020. An area in the spring and a different area in the fall. This season should give us some indication of the success of that effort. There have been a couple of pollinator studies done in the past few years along our roadsides by the state university, we had the results sent to us and should have it saved somewhere.

Table C-36. Survey responses for question 14 (types of resources developed to promote pollinator habitat within highway ROW)

Respondent	Pollinator habitat policy	Guidelines for vegetation management	Mowing policy	Selective herbicide use policy	Evaluation studies or studies to look at economics or quantification of benefits	Cost information	Other (please describe)
Alabama	-	-	-	-	-	-	-
Alaska	-	-	-	-	-	-	-
Arizona	-	Yes	-	-	-	-	-
Arkansas	Yes	Yes	Yes	Yes	-	-	-
California	Yes	Yes	Yes	Yes	-	Yes	-
Colorado	-	Yes	-	-	-	-	-
Connecticut	-	Yes	Yes	Yes	-	-	-
Delaware	-	Yes	Yes	-	-	-	-
District of Columbia	-	-	-	-	-	-	-
Florida	-	Yes	Yes	Yes	Yes	Yes	-
Georgia	-	-	-	-	-	-	Yes
Hawaii	-	-	-	-	-	-	-
Idaho	-	Yes	Yes	Yes	-	-	Yes
Illinois	Yes	Yes	Yes	Yes	-	-	-
Indiana	-	Yes	Yes	Yes	-	Yes	-
Iowa	-	Yes	-	-	-	-	-
Kansas	-	-	Yes	-	-	-	-
Kentucky	Yes	Yes	Yes	Yes	-	Yes	-
Louisiana	-	Yes	Yes	Yes	-	-	-
Maine	-	Yes	-	Yes	-	-	Yes
Maryland	Yes	Yes	Yes	Yes	-	Yes	Yes
Massachusetts	-	-	-	-	-	-	-

Respondent	Pollinator habitat policy	Guidelines for vegetation management	Mowing policy	Selective herbicide use policy	Evaluation studies or studies to look at economics or quantification of benefits	Cost information	Other (please describe)
Michigan	Yes	Yes	Yes	Yes	-	-	Yes
Minnesota	-	Yes	-	Yes	-	-	Yes
Mississippi	-	-	-	-	-	-	-
Missouri	-	-	-	-	-	-	-
Montana	-	Yes	Yes	Yes	-	-	-
Nebraska	-	Yes	-	Yes	Yes	-	-
Nevada	-	-	-	-	-	-	Yes
New Hampshire	-	-	-	-	-	-	Yes
New Jersey	-	-	-	-	-	-	-
New Mexico	-	Yes	-	-	-	-	-
New York	Yes	-	Yes	-	Yes	-	Yes
North Carolina	-	Yes	Yes	-	-	-	-
North Dakota	-	Yes	Yes	-	-	-	-
Ohio	Yes	Yes	Yes	-	Yes	Yes	-
Oklahoma	Yes	Yes	Yes	Yes	-	Yes	-
Oregon	-	-	-	-	-	-	Yes
Pennsylvania	-	Yes	Yes	-	-	Yes	Yes
Rhode Island	-	-	-	-	-	-	Yes
South Carolina	-	Yes	Yes	Yes	-	-	-
South Dakota	-	-	-	-	-	-	Yes
Tennessee	-	Yes	-	-	-	-	-
Texas	Yes	Yes	Yes	Yes	-	Yes	-
Utah	-	-	-	-	-	-	Yes
Vermont	-	Yes	Yes	Yes	-	-	-

Respondent	Pollinator habitat policy	Guidelines for vegetation management	Mowing policy	Selective herbicide use policy	Evaluation studies or studies to look at economics or quantification of benefits	Cost information	Other (please describe)
Virginia	Yes	Yes	Yes	-	-	-	Yes
Washington	-	Yes	Yes	Yes	-	-	-
West Virginia	-	-	-	-	-	-	-
Wisconsin	-	Yes	Yes	Yes	-	-	Yes
Wyoming	Yes	-	-	-	-	-	-
Total Yes	12	32	26	21	4	9	16

Table C-37. Resources submitted for question 14 (types of resources developed to promote pollinator habitat within highway ROW)

Respondent	Resource Description
Arizona	ADOT Roadside Development section: (see sections for Sample special provisions and Revegetation)
Arizona	ADOT Roadside Resources Program
Arizona	Roadside Vegetation Management Guidelines
Arizona	Preliminary Draft / Special Provisions
Arizona	Roadside Vegetation Management Guidelines
California	Assembly Bill 2062 (AB-2062)
California	Highway Design Manual (Chapter 900 – Landscape Architecture – Roadsides) 901.2(5) Ecological Function (Page 900-3) 904.3 Plant Selection (Page 900-8)
California	Erosion Control Toolbox: Specifying Seed and Plant Species
California	PDPM – Chapter 29, Section 2 Highway Planting "Wildflower Planting" (Page 29-19)
California	TransPlant Tool
Colorado	Colorado Pollinator Highway
Colorado	Integrated Roadside Vegetation Management Guide
Delaware	Enhancing Delaware's Highways
Idaho	Native Plants for Idaho Roadside Restoration and Revegetation Programs
Illinois	Illinois Department of Transportation SAVE Mowing
Illinois	Illinois Monarch Project: Mowing Guidelines for Pollinators
Illinois	Interstate Urban / Rural Classification for Final Mowing
Illinois	Mowing Policy Table
Illinois	Nationwide Candidate Conservation Agreement for Monarch Butterfly on Energy and Transportation Lands
Illinois	Standard Drawings for Culverts (Mowing)
Illinois	Standard Mowing for Traffic, Lighting, or IT Control Boxes at Access Control Fence

Respondent	Resource Description
Indiana	Indiana Design Manual
Indiana	INDOT Work Performance Standards
Indiana	Operations Memorandum – Vegetation Management
Indiana	Standard Drawing
Indiana	Standard Specifications
Indiana	Quantity Purchase Agreement
Kentucky	Current Status of Pollinator Habitat Locations and Flowers
Michigan	Pollinator Habitat Management Program
Minnesota	Integrated Roadside Management
Minnesota	Maintenance Manual Chapter 5 Roadsides
Minnesota	Pesticide Management on MnDOT Property
Montana	Statewide Integrated Roadside Vegetation Management Plan
Ohio	Guidelines for Mowing Reduction Outside Clear Zones for Compliance with the Candidate Conservation Agreement with Assurances (CCAA) for the Monarch Butterfly
Tennessee	TDOT Integrated Vegetation Management Program Guidelines
Vermont	VTrans State Highway System Mowing Best Practices (BMPs)
Vermont	Quote for Various Plant Seeds
Washington	Maintaining Vegetation Along Our Highways

Table C-38. Text responses for "Other" for question 14 (types of resources developed to promote pollinator habitat within highway ROW)

Text Responses for "Other"
We are currently revising our mowing best practices to better promote pollinator habitat.
Partnerships with outside agencies such as Operation Wingspan Pheasants Forever, Monarch Joint Venture.
Not at this time but hope to in the near future.
None at this time.
We currently have a research project in the works to evaluate pollinator habitat (include milkweed plants) and observation data of active pollinators on selective highways, interstates and ROWs. Study is from 2021-2023.
Partnered with Michigan State University to conduct research on pollinator best practices.
We are in the process of developing vegetation management guidelines. Our mowing policy allows for maintenance residencies to propose alternative practices, though it does not currently say to do this specifically for pollinators. Regarding studies, we have a research project with a university to evaluate altered mowing regime on pollinator species and invasives.
We ask mow and spray crews to identify and avoid concentrated patches of milkweed. Spray crews use a targeted approach by spot spraying unwanted brush.
Our state's DOT is in the process of developing many of these tools using our existing policies and resources.
Mowing guidelines, not policy
Our state's DOT has developed guidelines for vegetation management and mowing but as administrators change sometimes the thought process on policies change
Vegetation management does not specifically address pollinator habitat
None
Education to counties
Design guidelines and training given to field personnel.

Table C-39. Comments for question 14 (types of resources developed to promote pollinator habitat within highway ROW)

Comments
I strongly encourage you to look at the Right of Way as Habitat Working Group webpage a great deal of information has already been amassed. http://rightofway.erc.uic.edu/ Contact a research engineer at the state university. That group is probably the best resource for you to get other points of contact and data, plans etc. that have already been amassed. There are a few other studies on going currently that capture some of this information that you should search for as well, not sure if all are published yet, TRB, KY Transportation Cabinet and something from down in Texas....
They are mostly in the form of raw data still, as far as I remember.

Table C-40. Survey responses for question 15 (willingness to participate in follow-up interview)

Respondent	Response Text
Alabama	Yes
Alaska	-
Arizona	Yes
Arkansas	Yes
California	Yes
Colorado	Yes
Connecticut	Yes
Delaware	Yes
District of Columbia	-
Florida	Yes
Georgia	Yes
Hawaii	-
Idaho	Yes
Illinois	Yes
Indiana	Yes
Iowa	Yes
Kansas	Yes
Kentucky	Yes
Louisiana	Yes
Maine	No
Maryland	Yes
Massachusetts	Yes
Michigan	Yes
Minnesota	Yes
Mississippi	-
Missouri	-
Montana	Yes
Nebraska	Yes
Nevada	No

Respondent	Response Text
New Hampshire	**Yes**
New Jersey	No
New Mexico	Yes
New York	Yes
North Carolina	Yes
North Dakota	Yes
Ohio	Yes
Oklahoma	Yes
Oregon	Yes
Pennsylvania	Yes
Rhode Island	No
South Carolina	Yes
South Dakota	Yes
Tennessee	Yes
Texas	Yes
Utah	Yes
Vermont	Yes
Virginia	Yes
Washington	Yes
West Virginia	Yes
Wisconsin	Yes
Wyoming	Yes
Total Yes	42
Total No	4
Total No Response*	0

* Based on 46 survey respondents

Table C-41. Comments for question 15 (willingness to participate in follow-up interview)

Comments
This would include several people from our DOT.
Not sure how helpful we will be since we are still working through these same questions.
The state DOT vegetation manager, the driving force, and most of the knowledge and experience behind this effort retired in January 2021. I was his assistant and his replacement is pending maybe by mid-April. I don't have all the answers you would be looking for.

Table C-42. Comments for question 16 (additional comments regarding the promotion of pollinator habitat within highway ROW)

Comments
I am interested to see what our DOT neighbors are doing for pollinators. We were interested in the CCAA but due to section 106 concerns we are not able to sign up for the CCAA. We are going to working on a plan with our state and USFWS partners due to the monarch. I used to work for the state agency doing monarch and pollinator research and we did conduct roadside surveys. I know that Xerces has just started a bumblebee atlas project in your state. They have been great here and one of the habitat types is roadsides. I have been collecting data for them and hope to use their data set to evaluate impacts to pollinators as we move forward with our plan.
Striking the balance of the available space, adjacent property use, proximity to fire all need to be considered.
I would be interested to know what FHWA would fund in association with highway projects. In the past beatification is a cost that the feds don't support. Wondering if there is any truth to this. Most highway projects have Federal funding, so this is an important question to ask.
We do not anticipate putting pollinator plots along our highways.
We received Federal funding for the program and for the effort to review and designate locations of rare and threatened plant species on our rights-of-way.
We received our certificate of inclusion into the monarch CCAA and are in the preliminary stages of developing agency policies.
Focus on killing/controlling the bad plants and the good plants will likely return in due time.
Our DOT is currently working with the state Fish & Game Department under a grant to improve habitat for pollinators in the ROW and possible inclusion into the CCAA.
Collaborate with state Wildflower Foundation to promote pollinator habitat.
In the landscape architecture section, where plant species are selected for ROW restoration, plants are selected that will benefit pollinators.
We install signs in designated pollinator and monarch habitat areas within our rest areas to inform the public of our efforts. We developed promotional materials and we speak with private groups to encourage citizens to plant pollinator habitat.
We have been a member of the Rights of Way Habitat work group since its inception.
We've been working on this for 4ish years now, but it's slow to change. Lots of things are in process or rebranding.
Our DOT has been a member of the Candidate Conservation Agreement with Assurances (CCAA) Task Force since the committee was formed. We have a successful pollinator habitat program with nearly two square miles of high value pollinator habitat in development across the state.
Please let me know when this project is completed or send a link to the report when it is posted.
I look forward to seeing the results of this study!

Comments
Within the environmental / natural resource group, we are trying to find ways to develop more habitat for pollinators that the rest of the department will support especially through the maintenance division. I see a need for public education & outreach for understanding of the appearance of habitat.
Currently interested in creating a pollinator habitat at a DOT property such as a rest area or welcome center.

APPENDIX D. SUMMARY OF PRACTITIONER LITERATURE

Table D-1. Summary of practitioner literature for pollinator habitat within the right of way

State	Title	Reference	Summary
-	Roadside Revegetation: An Integrated Approach to Establishing Native Plants and Pollinator Habitat	Armstrong et al. 2016	Presents a framework to help establish and monitor pollinator habitat along the roadside. Describes four planning phases: orientation, site assessment, vegetation analysis, and integration. Also provides guidance on implementation, monitoring, and management.
-	Evaluating the Suitability of Roadway Corridors for Use by Monarch Butterflies	Cariveau et al. 2020	Developed the following products to help assess possible roadway corridors for monarch butterfly habitat: landscape prioritization model, rapid assessment protocol, roadside monarch habitat calculator, and decision support tools. Findings suggested that roadsides have potential to provide habitat for monarchs.
-	Effects of Simulated Highway Noise on Heart Rates of Larval Monarch Butterflies, Danaus Plexippus: Implications for Roadside Habitat Suitability	Davis et al. 2018	Performed experiments that showed increase in heart rate of 16% to 17% when developing larvae were exposed to 2 hours of simulated highway noise. In addition, continuous exposure to simulated traffic noise for 7 or 12 days resulted in no change in heart rate for the larvae.
-	Pollinators	FHWA n.d.	Provides general information about pollinators, including legislation/policy/guidance, links to resources, funding sources, and DOT policies.

State	Title	Reference	Summary
-	Pollinators and Roadsides: Best Management Practices for Managers and Decision Makers	FHWA 2016	Provides information on implementation of practices to enhance the quality of roadside habitat for pollinators, including modification of vegetation management practices and using plant materials that support pollinator habitat to augment native vegetation on the roadside.
-	Technical Manual for Maintaining Roadsides for Pollinators Establishment, Restoration, and Maintenance: A Guide for State DOT Managers and Staff	Galea et al. 2016	Technical manual that describes BMPs for roadside pollinators, such as planning for pollinators, site selection, plant selection, mowing and spraying practices, removal of invasive plants, Adopt-a-Highway programs, and monitoring.
-	Literature Review: Pollinator Habitat Enhancement and Best Management Practices in Highway Rights-of-Way	Hopwood et al. 2015a	Provides overview of existing literature on various topics for pollinator habitat, such as vegetation management and effects of roads on habitat for pollinators.
-	Roadside Best Management Practices that Benefit Pollinators	Hopwood et al. 2015b	Provides guidance for Best Management Practices (BMPs) for promoting pollinators, including modifying methods for management of roadside vegetation, augmenting native roadside vegetation with plant materials that support pollinator habitat, and considering native plants and pollinator habitat concerns during design of the roadside landscape.
-	Identifying the Current State of Practice for Vegetation Management Associated with Pollinator Health and Habitat: An Interview Report	Hopwood et al. 2016	Summaries of interviews with nine state DOTs regarding their practices to develop and protect pollinator habitat on the roadsides.

State	Title	Reference	Summary
-	Pollinator Habitat Programs	Kurgan et al. 2016	Webinar presentation that provides overview of pollinator habitat programs in Minnesota, Texas, and Virginia.
-	No Boundaries Roadway Maintenance Pooled Fund Program Update	Patterson et al. 2019	Presentation that provides update on No Boundaries Roadway Maintenance Pooled Fund.
-	Pollinator Partnership	Pollinator Partnership 2021	Website for Pollinator Partnership. Includes guides for ecoregional planting for pollinators for different regions of the United States.
-	Rights-of-way as Habitat Working Group	University of Illinois-Chicago 2018	Provides resources for promoting pollinator habitat.
-	Pollinator Conservation Resource Center	The Xerces Society 2021	Provides resources by region to facilitate planning, establishment, and maintenance of pollinator habitat.
Arkansas	Arkansas Monarch and Pollinator Conservation Plan	Arkansas Monarch Conservation Partnership 2018	Describes statewide plan for monarch and pollinator habitat. Includes various goals and strategies for monarch and pollinator habitat conservation, enhancement, and restoration; research and monitoring; outreach and education; capacity, governance, and funding; and collaboration and partnerships
Arkansas	Arkansas NRCS Pollinator Conservation Planning Book	Arkansas NRCS 2020	Provides Arkansas guidance for recognizing, establishing, preserving, enhancing, and maintaining pollinator habitat.
Arkansas	Collaborative Implementation of Integrated Roadside Vegetation Management Practices: Maintenance Mows for Monarchs	Ewing et al. n.d.	Poster presentation of ArDOT's use of IRVM practices to promote pollinator habitat. ArDOT divides the roadside into three parts: clear zone, transition zone, and natural zone. Also presents standard and special specifications for wildflower seedings.

State	Title	Reference	Summary
Colorado	Pollinator Highways: Managing Roadways with Pollinators in Mind	Banovich n.d.	Presents Colorado DOT efforts for pollinator habitat, including a pilot project at I-76 welcome center.
Colorado	CDOT Pollinator Habitat Enhancement Plan (2020)	Colorado DOT 2020a	Describes four strategies for Colorado DOT to promote roadside pollinator habitat: improving and protecting habitat, development of native plant database, partnerships, and identification of funding resources.
Colorado	Integrated Roadside Vegetation Management Guide	Colorado DOT 2020b	Guide for IRVM in Colorado, including management strategies for pollinators.
Colorado	Pilot Project Phase 1 Final Summary Report: I-76 Colorado Pollinator Highway	Colorado DOT 2020c	Provides overview of pilot project to establish pollinator habitat on a four-mile section of I-76.
Delaware	Enhancing Delaware Highways	Barton et al. 2009	Presents roadside management guidance for Delaware DOT but does not specifically address pollinators.
Illinois	Operation Habitat	Dobbs 2018	Presentation that discusses Illinois DOT's efforts to promote pollinator habitat, including changes to mowing policy, certification of monarch waystations, and creation of a Right of way as Habitat Committee.
Illinois	Pollinators What's the Buzz?	Hargrove et al. 2017	Presentation that provides overview of Illinois DOT efforts to support pollinator habitat, including IRVM and use of monarch and pollinator seed mixture.
Illinois	New IDOT Mowing Approach to Help Protect Monarch Butterfly, Pollinator Populations in Illinois	Illinois DOT 2017	Press release announcing changes to Illinois DOT's mowing policy, limiting the width of mowing to 15 feet beyond the roadway edge.

State	Title	Reference	Summary
Illinois	Illinois Monarch Project: Mowing Guidelines for Pollinators	Illinois Farm Bureau 2019	Provides guidance for roadside mowing, such as avoiding mowing from May - June 30 and August 15 to September 30 and mowing one third of the road ROW each year.
Indiana	Vegetation Management Toolbox Benefits Indiana Bees and Budgets	FHWA 2015b	Case study of pollinator-friendly practices by Indiana DOT. Indiana established Hoosier Roadside Heritage Program in 1990s and modified its vegetation management practices in 2014. Indiana divides ROW into four zones for vegetation management: Zone 1 (paved road), Zone 2 (safety or clear zone), Zone 3 (selective zone), and Zone 4 (minimal vegetation management. Clear zone (30 ft from pavement) is the only area that is mowed.
Indiana	Best Management Practices for Indiana Pollinator Habitat	Jacquart et al. 2017a	Provides guidance on establishing pollinator habitat, setting pollinator habitat goals, and special considerations for establishing and maintaining large-scale plantings.
Indiana	Recommended Indiana-native Plants for Attracting Pollinators	Jacquart et al. 2017b	Provides table of wildflowers suitable for establishing pollinator habitat in Indiana. Includes attributes such as sun and soil requirements, bloom time, and associated species.
Iowa	Creating Habitat for Monarchs and Other Pollinators	Iowa DNR n.d.	Provides guidance on establishing and maintaining pollinator habitat for both large and small plots.
Iowa	Iowa Living Roadway Trust Fund	Iowa DOT n.d.	Provides information on Iowa Living Roadway Trust Fund, including IRVM practices and native plant lists.

State	Title	Reference	Summary
Iowa	We Need Pollinators and Pollinators Need Our Help	Iowa DOT 2019	Includes summary of Iowa DOT practices to preserve pollinator habitat, including native roadside plantings, minimizing mowing and spraying, and use of special seed mixes designed for specific projects.
Iowa	Pollinators in Iowa	Iowa Living Roadway Trust Fund n.d.	Includes information regarding various pollinator species and discusses maintenance practices to promote pollinators, such as limiting mowing and herbicide applications and establishing native vegetation.
Maine	Maine Native Plants for Roadside Restoration	McCargo 2018	Provides guidance for planting or maintaining 70 species of wildflowers, shrubs, and grasses on the roadside
Maryland	Evaluating Integrated Roadside Vegetation Management (IRVM) Techniques to Improve Pollinator Habitat	Kuder 2019	Field evaluation to compare effects of selective herbicide use, annual fall mow, and traditional frequent mowing methods on bee habitat. Results indicated that both selective herbicide use and fall mow led to greater floral abundance and diversity and bee abundance than traditional mowing.
Michigan	Pollinator Habitat Management Program	Michigan DOT n.d.	Summarizes Michigan DOT's IRVM approach for the improvement and creation of pollinator habitat. Michigan divides the roadside into three zones: pavement edge zone (regularly mowed), operational zone, and buffer zone.
Minnesota	Partnerships for Promoting Pollinator Habitat	CTC and Associates 2016	Describes ways to establish and maintain partnerships to help promote pollinator habitat. Discusses MnDOT practices and results from a survey of DOT practitioners regarding their partnership programs.

State	Title	Reference	Summary
Minnesota	Pollinator Best Management Practices for Roadsides and Other Rights-of-Way	Minnesota Department of Agriculture n.d.	Brochure that describes Best Management Practices (BMPs) for minimizing negative impacts to pollinators, improving existing pollinator habitat, and creating new pollinator habitat.
Minnesota	Pollinators and MnDOT	Minnesota DOT 2021b	Provides overview of Minnesota DOT practices to promote pollinator habitat, including links to resources such as seeding manual.
Mississippi	Alternative Mowing Regimes' Influence on Native Plants and Deer	Guyton et al. 2014	Investigated impacts of reducing mowing through seeded plots and a motorist survey. Overall, results indicated that one mowing per year in late fall could make the ROW less expensive to maintain and more visually appealing to motorists.
Nebraska	NDOT Roadside Vegetation Establishment and Management	Nebraska DOT 2020	Discusses Nebraska DOT's practices for seeding and managing roadside vegetation. Indicates that some areas of the ROW should not be mowed between May 1 and October 1 to accommodate pollinator life cycles.
New York	New York State Department of Transportation Rochester Region's I-390 Pollinator Pilot	Piecuch 2016	Presentation that summarizes New York State DOT pilot project to modify mowing practices to benefit pollinators.
North Carolina	Asset Management Aided Through Vegetation Management / Zoysia Grass Along NC Roadsides	Gannon et al. 2013	Conducted experiments to investigate plant growth regulators, herbicides, and practices for warm-season turfgrass seed and sod. Results indicated that plant growth regulators could help in reducing the number of mowings.

State	Title	Reference	Summary
North Carolina	Economic Analysis of Vegetation Management Practices	Martin et al. 2017	Research study to investigate economic aspects of vegetation management practices. Results indicated that replacing one mowing cycle with one plant growth regulator (PGR) cycle would yield $2.5 million in annual savings.
North Carolina	North Carolina Pollinator Toolkit	North Carolina Botanical Garden 2019	Provides information regarding species selection, planting and maintenance specifications, timeline for establishment of pollinator habitat, and funding opportunities.
North Carolina	Guidelines for Planting Within Highway Right of way	North Carolina DOT 2016	Provides direction regarding plant setbacks, setback variance, layouts for landscaping at roundabouts and interchanges, maintaining proper intersection site distance, and plant selection.
Ohio	Statewide Roadside Pollinator Habitat Program Restoration Guidelines and Best Management Practices	Ohio Department of Transportation and Davey Resource Group 2016	Guidance document for Ohio DOT staff for the development and maintenance of highway pollinator habitat within the ROW. Includes sections on site selection, plant selection, roadside seed mixes, site preparation, and maintenance and monitoring after establishment.
Pennsylvania	The Pennsylvania Pollinator Protection Plan (P4)	The Pennsylvania State University 2021	Provides suggestions for best practices to promote pollinators, based on input from various stakeholders.
Tennessee	Pollinator Habitat Program	Tennessee DOT n.d.	Summarizes Tennessee DOT's pollinator habitat program, including locations of plantings for pollinator habitat.

State	Title	Reference	Summary
Texas	Strategic Mowing Benefits Wildflowers, Pollinators, and the State Economy	FHWA 2015a	Case study of pollinator-friendly practices by Texas DOT. Texas mows after the spring bloom and fall bloom seasons and uses spot treatments for herbicides. A vegetation manager is responsible for ensuring the proper use of vegetation management methods in each of 25 districts.
Virginia	Pollinator Habitat Program	Virginia DOT 2021	Provides general overview of VDOT's pollinator program, including planting pollinator waystations.
Washington	WSDOT Continues Commitment to Environmental Stewardship with Pollinator-Friendly Vegetation Management Practices	FHWA 2015c	Case study of pollinator-friendly practices by WSDOT. In 2014, WSDOT implemented a new roadside policy, including reduced mowing. Other practices by WSDOT include waiting to mow until after the blooming and nesting season and applying principles of plant succession.
Washington	Creation of Pollinator Habitat	Washington State DOT n.d.	Discusses considerations when creating pollinator habitat, such as using various native plants and mowing in late fall.
Washington	Promoting the Health of Pollinators along WSDOT's Roadsides	Washington State DOT 2016	Provides overview of WSDOT's policies and practices to promote pollinator habitat, such as limited mowing and diversity of native plant species.
Washington	Design - Roadside and Site Development - Pollinators and the Roadside	Washington State DOT 2021b	Includes links to various resources, such as charts showing flowering periods for native plants by region of Washington State.