



Interview Report: Identifying the Current State of Practice for Vegetation Management Associated with Pollinator Health and Habitat

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Acronyms and Abbreviations

DOTs	departments of transportation
FHWA	Federal Highway Administration
IRVM	integrated roadside vegetation management
ROW	rights-of-way
USFWS	United States Fish and Wildlife Service

Chapter 1

Introduction

In this task, Xerces Society for Invertebrate Conservation and ICF International interviewed State departments of transportation (DOTs) and roadside restoration experts who work with DOTs to document existing roadside vegetation management practices and obtain feedback from those professionals about the feasibility of implementing roadside vegetation management strategies that can benefit pollinators. When selecting the interviewees, we sought out professionals from different geographical regions. This report describes interview information on the state of the practice in roadside vegetation management as relates to pollinators, highlighting both successes and challenges in improving pollinator habitat.

We used several criteria to identify individuals to interview. The DOT representatives we interviewed were selected either from States where some pollinator-friendly conservation practices are already being implemented, or from States that have expressed an interest in implementing pollinator-friendly practices. In our selection of restoration ecologists with expertise in roadside habitat, we focused on leaders in the field who understand the science, practice, politics, and economic issues that are related to roadside vegetation management and pollinator conservation.

Once we had identified our interviewees, we developed sets of questions to distribute to them. Our questions were derived from the findings of our previously completed literature review (Task 2).

The literature review found that adjusting vegetation management techniques to accommodate pollinator resource needs, as well as enhancing and restoring native vegetation to roadside habitat are key steps to improving the quality of roadside habitat for pollinators. Roadside habitat restoration and modifications to the frequency, timing, and scale of vegetation management practices can help to mitigate some of the threats associated with roads that pollinators face.

Integrated roadside vegetation management (IRVM) can benefit pollinators by employing limited, judicious use of mowing and herbicides. Roadside vegetation management alterations that have been found to improve the quality of the roadside habitat for pollinators include:

- Roadside vegetation should be mown no more than twice during the growing season.
- Mowing should be timed to minimize disruption to the life cycles of rare, endemic, or sensitive and declining species of pollinators.
- Delaying mowing until the fall or after first frost will benefit a variety of pollinators by allowing flowering plants to bloom uninterrupted throughout the growing season and by reducing the risk of mortality by mower to larval stages that reside on vegetation (e.g., butterfly caterpillars, larval flower flies). Herbicide use, and subsequent impacts of herbicides on pollinators, can be reduced through the use of selective herbicides, spot-spray applications, and timing of applications to life stages when the weed is most vulnerable.
- Training provided to roadside managers about the timing and selection of chemicals for particular weeds, weed identification, and native plant identification can also reduce the amount and frequency of herbicide use.

- If sheep or goats are used to graze invasive weeds on roadsides, take into account the timing of the life cycles of rare, endemic, or sensitive and declining species of pollinators.
- If fire is used, rotational burning of every 3 to 5 years allows time for pollinator populations to recover.
- Native plants on roadsides sometimes face threats from pesticide drift from adjacent land, intentional herbicide use, or excessive mowing or haying from landowners living adjacent to roadside rights-of-way (ROW).

Specific findings on the value of using native plants for revegetating or restoring roadsides include:

- Native plants can be an effective roadside vegetation management tool.
- Native plants can provide effective erosion control, buffer against invasive non-native weeds, are adapted to local conditions, require fewer inputs, reflect a region's natural heritage, and support more wildlife, including pollinators.
- Pollinators are more abundant and diverse on roadsides with native plants.
- Seed mixes that include species that are adapted for particular site conditions will establish more successfully than a general regional mix.
- Seed mixes can include wildflowers that have sequential and overlapping bloom times to provide resources for pollinators throughout the growing season.

Roadside plants can include host plants for butterflies (e.g., milkweeds for monarch butterflies) as well as forage for a wide range of pollinator species. We developed our interview questions based on these findings, and created two sets of interview questions to distribute to our interviewees. The interviews for DOT personnel consisted of 31 questions, and the interviews for restoration experts consisted of 18 questions. Although there were some interview questions that were asked of both DOT personnel and restoration experts, there were also unique questions posed to each group to reflect their varying experiences and expertise. Our questions fell into these categories:

- General policies and procedures for roadside management,
- Current practices that benefit pollinators,
- Opportunities and constraints for pollinator-specific roadside management practices, and
- Opportunities and constraints for increasing the value of new roadside plantings to pollinators.

The specific interview questions that were distributed to State DOT personnel are included in Appendix A, and the questions that were distributed to roadside restoration experts are included in Appendix B. The surveys were distributed via email, and one-hour phone interviews were scheduled. Most, but not all, of the individuals whom we interviewed returned written responses to the interview questions, in addition to the verbal responses provided during the phone interviews.

We conducted 14 one-hour phone interviews. We interviewed 27 individuals, including 20 individuals from nine State DOTs, as well as seven individuals with expertise in roadside restoration ecology. The nine State DOTs interviewed included Arizona, California, Florida, Idaho, Iowa, Ohio, Oregon, Minnesota, and New York. A list of the DOT representatives we interviewed can be found in Appendix C, and a list of the restoration experts we interviewed is included in Appendix D.

Chapter 2

Summary of Interview Responses

The information we obtained from our interviews fell into four main categories: 1) current roadside management practices used by State DOTs, 2) current practices that can benefit pollinators, 3) limitations to implementing additional practices to benefit pollinators, and 4) what is needed to overcome limitations and improve roadside habitat for pollinators.

Current Roadside Management Practices of State DOTs

Of the nine of the State DOTs we interviewed, five—California, Iowa, Idaho, Oregon, and New York—have formal IRVM programs that are supported by policy, training, and guidance documents. The four agencies without a formal IRVM program—Arizona, Florida, Ohio, and Minnesota—report using aspects of IRVM. Both Arizona and Minnesota mentioned that a lack of formal policy and centralized structure have led to uneven implementation of IRVM across their States. Training to support the use of IRVM ranged from the basics, such as Florida’s training on mechanical and chemical controls, to more extensive training that includes plant identification for maintenance staff and routine training for design staff, as in New York.

The roadside vegetation management tools that are most often employed by State DOTs interviewed are, in order from most used to least: mowing, herbicide use, brush removal, native vegetation, biological control, fire, and grazing. All nine States used mowing, herbicides, brush removal, and native vegetation as roadside vegetation management tools (Table 1). Biological control is used by six States, fire is used by five States, and grazing is used by one State (Table 1).

Table 1. Roadside Vegetation Management Tools Used by State DOTs

State DOT	Mowing	Herbicides	Brush Removal	Native Vegetation	Biological Control	Fire	Grazing
Arizona	✓	✓	✓	✓			
California	✓	✓	✓	✓	✓	✓	✓
Florida	✓	✓	✓	✓	No	✓	
Iowa	✓	✓	✓	✓	✓	✓	
Idaho	✓	✓	✓	✓	✓		
Ohio	✓	✓	✓	✓			
Oregon	✓	✓	✓	✓	✓	✓	
Minnesota	✓	✓	✓	✓	✓	✓	
New York	✓	✓	✓	✓	✓		

Mowing is the tool most frequently used by the State DOTs that we interviewed. All States intensively mow the immediate edge along the shoulder, maintaining that area as a safety zone. All States do mow entire roadsides from the safety zone to the fenceline at some point, though frequency and

timing of that mowing varies between States and also within some States (Table 2). Four States (Iowa, Ohio, Minnesota, and New York) limit mowing to a maximum of once a year, with mowing typically taking place either in mid-summer or in the fall. Idaho and Oregon limit mowing of the entire roadside to a maximum of twice per year. Mowing in these States takes place in the late spring and early fall, or mid-summer and early fall. Mowing of the entire roadside can take place throughout the year in Arizona, California, and Florida. In Arizona and California, roadsides may be mown in certain regions for fuels reduction to avoid wildfires. Florida has the most intensive mowing procedures of the State DOTs we interviewed: in some areas of the State roadsides are mowed up to 20 times a year.

Table 2. Frequency and Timing of Roadside Mowing by State DOTs Interviewed

State DOT	Frequency of Mowing of the Entire Roadside in One Year	Timing of Mowing
Arizona	Exact number not provided	Throughout the year
California	Limit mowing when possible (some areas need to be mowed to reduce fire risk)	Spring and summer
Florida	1-20	Throughout the year
Iowa	0-1	Mid-August
Idaho	1-2	Early July, late October
Ohio	0-1	Fall
Oregon	1-2	Late spring, early fall
Minnesota	0-1	Within the month of August
New York	0-1	At discretion of regional maintenance offices

Mowing exceptions to protect sensitive plants exist in Arizona, California, Florida, and Oregon. In addition to any mowing of roadsides that might be conducted by transportation authorities, in some States, roadside vegetation may also be mowed for hay by private citizens who can hay the roadside adjacent to their property and use it for animal fodder. California, Iowa, and Minnesota DOTs all reported haying by landowners within their State. Additionally, Iowa and Minnesota DOTs reported that haying can occur outside of existing restrictions (e.g., Minnesota's mowing law) on timing of mowing, can occur multiple times per growing season, and occurs without landowners obtaining the proper permits.

All nine State DOTs use herbicides throughout the growing season as needed to control noxious weeds, invasive weeds, and encroaching woody vegetation. Herbicides are also applied in areas that cannot be mown, such as under guard rails or on gravel shoulders. All nine State DOTs use some broad-spectrum (non-selective) herbicides. Various methods of application include spot sprays using a backpack sprayer, spot sprays using nozzles off of trucks, and boom applications. Several State DOTs do generally time herbicide applications for peak effectiveness, but others mentioned that it was challenging to time applications to the optimal weed stage due to limited staff and resources.

It is a priority to use native plant species rather than introduced plant species in five of the nine States interviewed: Arizona, California, Iowa, Idaho, and Oregon (Table 3). In these five States, many new

plantings (usually erosion control projects) include native species or are exclusively native species. Idaho, for example, frequently uses mixes with six species that include native grasses, native wildflowers, introduced grasses, and introduced forbs, while Arizona's seed mixes include 15–25 exclusively native species comprised primarily of wildflowers and shrubs. Native plants are most often used in rural areas, and ornamental plantings are more common in urban areas. Individuals interviewed were aware of many of the benefits of using native species in roadside revegetation projects.

Other State DOTs are using native plants to a lesser degree (Table 3). New York State DOT uses native species when native species are the most cost-effective and practical options. In practice, this means that about half of the transplanted trees and shrubs they use are natives, but the vast majority of seeded areas are seeded with non-native turfgrass species. Minnesota DOT uses native species in one-third of its new plantings and a pasture mix of introduced species in the other two-thirds of plantings. Ohio DOT primarily uses introduced grasses in its new plantings, but has recently begun trialing several acres of plantings with native species. Florida DOT also predominately uses nonnative plants in its mixes but is interested in increasing the use of native plant material in roadside revegetations.

Biological control agents such as herbivorous beetles are used by six State DOTs to control weeds like purple loosestrife and leafy spurge (see Table 1 for a list of States that use biocontrol). Fire is used on a limited basis in all of the five State DOTs that utilize it (see Table 1 for a list of States that use fire), and is primarily used on remnant roadside habitat or special conservation sites. When used, prescribed burning is often conducted with local partners (e.g., Florida Forest Service), and fires are contained with 15 foot mown or wetted firebreaks and tankers on site. California is the only State DOT interviewed that uses grazing, and it is not a common practice within the State. Goats are used to graze to reduce fire fuel in places that cannot be mowed.

Only four State DOTs provided estimates of annual costs for roadside maintenance, ranging from averages of \$248 per acre to \$414 per acre. Mowing is more expensive per acre in States where frequent mowing occurs, such as in California (\$213/acre) and Florida (\$146/acre). In contrast, Iowa DOT spends much less on mowing (\$16/acre) but does invest more up front to establish native vegetation. Although the initial cost of establishing native vegetation is high (\$720/acre), it is a one-time expense rather than an annual cost and allows Iowa to reduce overall mowing expenses over time because native vegetation requires little mowing.

Table 3. Examples of How State DOTs Incorporate Native Plants into New Roadside Plantings

State DOTs that Prioritize Use of Native Plants	Examples of Uses of Native Plants
Arizona	New projects include 15–25 ecoregional native species (3–5 species are grasses, the rest are forbs and some shrubs).
California	Erosion control projects are 99% native species; landscape projects include 40–60% native species.
Iowa	All plantings except shoulders, medians, and urban areas are entirely native.
Idaho	Most new plantings include native species (and introduced). Some projects are entirely native species.
Oregon	Plantings in rural areas are nearly entirely native, with an emphasis on ecoregional species of native forbs and grasses. In urban areas plantings may be more ornamental but still use some natives.
State DOTs that Do Not Prioritize Use of Native Plants	Examples of Uses of Native Plants
Florida	Increasing the use of native plants.
Ohio	Conducting several trials of prairie plantings in areas without high weed pressure.
Minnesota	30% of new plantings are native, 70% are planted with a pasture mix of nonnative species.
New York	Use natives when cost-effective and practical. About 50% of shrubs and trees used are natives, while seeded areas are usually planted with nonnative turf species.

Insecticides are rarely used in roadside management programs. Minnesota DOT and Oregon DOT rarely use insecticides, but will treat certain trees in the rights-of-way if the trees are at risk due to invasive pests. California DOT has used insecticides on roadsides for vector control or to limit the spread of invasive crop pests, for example, spraying roadsides near orchards or vineyards with insecticides to control the glassy-winged sharp shooter (*Homalodisca vitripennis*). Based on our interviews, the primary chemicals employed by State DOTs for road maintenance are road salts. All States interviewed excepting Arizona DOT and Florida DOT use road salts in winter months.

State DOTs are not currently making adjustments to manage roadsides for pollinators in general, though they recognize that several of their current practices benefit pollinators inadvertently. Where federal or state listed endangered or threatened pollinator species are present, State DOTs must work with the United States Fish and Wildlife Service (USFWS) and/or State departments of wildlife, which regulate listed species, to develop management plans and obtain permits for impacts. Six of the nine States have adjusted roadside vegetation management practices to reduce harm to pollinators protected by State or federal law (Table 4). For example, when beginning new construction projects, Arizona develops plans with specifications to salvage and relocate agave and saguaro, plants that are critical to the endangered lesser long-nosed bat. Oregon DOT maintains special management areas on its roadsides for three federally listed butterflies, Fender's blue butterfly, Oregon silverspot butterfly, and Taylor's checkerspot butterfly.

Of the transportation agency personnel whom we interviewed, no one was aware of a State or local law that mandated pollinator habitat protection. However, Oregon DOT was aware of Oregon’s Pollinator Health Task Force, a directive of the governor. The Task Force recently published draft recommendations, one of which stated that “ODOT should develop a plan for using native plant material along transportation corridors to establish pollinator habitat on public land.”

Table 4. State DOTs that Currently Adjust Roadside Maintenance Practices to Reduce Impacts on Rare, Endemic, or Sensitive and Declining Pollinators

State DOT	Rare, Endemic, or Sensitive and Declining Pollinator	Conservation Status
Arizona	Lesser long-nosed bat (<i>Leptonycteris yerbabuena</i>)	Endangered (Federal listing)
California	Monarch butterfly (<i>Danaus plexippus</i>)	None at present
Florida	Frosted elfin butterfly (<i>Callophyrus irus</i>)	Endangered in DE, MD, NH, OH; Threatened in CT, MI, NJ, NY, WI; Species of concern in MA, RI
Iowa	Poweshiek skipperling (<i>Oarisma Poweshiek</i>)	Endangered (Federal listing)
Oregon	Fender’s blue butterfly (<i>Icaricia icarioides fenderi</i>) Oregon silverspot butterfly (<i>Speryeria zerene hippolyta</i>) Taylor’s checkerspot butterfly (<i>Euphydryas editha taylori</i>)	Endangered (Federal listing) Threatened (Federal listing) Endangered (Federal listing)
New York	Karner blue butterfly (<i>Lycaeides melissa samuelis</i>)	Endangered (Federal listing)

When asked whether pollinator conservation measures along roadsides are compatible with driver safety, DOT representatives all indicated that roadside pollinator habitat would be safe for drivers if certain considerations were met. For example, DOT representatives recommended that when maintaining roadside pollinator habitat, the safety zone adjacent to the pavement should be mowed regularly and vegetation in high-crash zones should be kept low. Representatives also recommended consideration of site-specific factors when planning during the design stage; for example, avoiding the use of tall vegetation within the lines of sight at intersections and around curves.

Roadside Habitat for Pollinators – Current Practices that are Benefiting Pollinators

Identifying and Managing Existing Roadside Habitat

Remnant habitat is very valuable to pollinators. Inventories to identify intact existing roadside remnant habitat are important steps to protecting habitat and can save money that might be unnecessarily spent on excessive management. Several States have identified remnant roadside habitat and recognize the value of that habitat by managing it with care. “The wildflowers are already there,” a State DOT representative told us. “We just need to stop mowing them down.” One of the restoration ecologists we spoke with observed that, “Sometimes [these roadside sites] just need a good burn or mowing to return as beautiful natives.” Florida, one of the most biologically diverse

places in North America, has recently adopted a new procedure to focus on identifying naturally occurring wildflower areas and managing approaches for those areas.

Reduced Mowing Frequency

Outside of urban areas, most States we interviewed mow the entire roadside from safety zone to fence line only once or twice per growing season (Table 2). State DOTs have various reasons for limiting mowing, including economic savings, reduced emissions, and benefits to nesting grassland birds. Mowing roadside vegetation no more than twice per growing season also helps to maintain the quality of roadside habitat for pollinators. Although no States expressly limit mowing to benefit pollinators, several acknowledged that it was an incidental advantage.

Roadside mowing in some parts of Florida takes place up to twenty times a growing season, which has caused controversy with some residents. Jeff Castor, State Transportation Landscape Architect with Florida DOT, describes the situation: “Environmentally conscious citizens called us to complain that we were mowing down wildflowers and butterfly habitat. There would be butterflies on the side of the road feasting on the native vegetation and we would come in and mow it all down and we would get people naturally upset with us.” A creative solution emerged over time: a public partnership. Florida DOT isn’t able to respond to a garden club or individual that wants less roadside mowing. Instead, if citizens in a certain county want less roadside mowing to preserve existing stands of wildflowers, they are asked to bring Florida DOT a “wildflower resolution” approved by that County’s board of commissioners. Then Florida DOT will develop a mowing plan to accommodate the resolution. A model resolution can be found on the Florida Wildflower Foundation’s website (<http://flawildflowers.org/resolution.php>). Now, 27 out of Florida’s 67 counties have moved to adopt wildflower resolutions. These counties “make a commitment to saying they want to enjoy the visibility of wildflowers for whatever reason, some do it to attract nature-based tourism, some doing it to help their farms, for whatever reason,” Castor says. “Some are very specific in their resolutions where they want to make a wildflower corridor. Others authorize their public works department to identify areas to convert because they are anxious to get this process going but haven’t had the time to actually identify places.” If successful, Florida’s unique grassroots approach to protecting wildflowers at the county level also has great potential for pollinator conservation.

Managing Noxious and Invasive Weeds

The prevalence of noxious weeds and invasive species on roadsides reduces pollinator abundance and diversity. By eradicating or reducing noxious and invasive weeds, weed control measures can improve the quality of habitat for pollinators. Managing noxious weeds is a priority for all of the State agencies interviewed. Additionally, some States also attempt to control invasive species that are not on their noxious weeds list, or make special efforts to eradicate weeds following disturbances caused by construction projects. For example, Minnesota DOT works to control Queen Anne’s lace (*Daucus carota*), a species that is invasive but is not considered noxious by State law. In its construction specifications, Arizona DOT stipulates control of noxious and invasive species following disturbance of sites, and this practice allows the newly planted desirable species to establish quickly and successfully.

Using Native Species

Native species of wildflowers, grasses, shrubs, and trees have been used successfully in roadside plantings, according to the people we interviewed. In some States, the use of native species is routine. Arizona, Iowa, and Oregon have been using native species extensively for several decades. These States have worked with seed vendors to increase species availability and have partnered with local agencies and experts to increase the success of establishment. LeRoy Brady of Arizona DOT highlighted an approach that helped the DOT increase the availability of native species: work with seed suppliers to grow or collect seeds for certain species and pay 20-30 percent above market value on those species. Iowa has a requirement to use local ecotype seed in county and State roadside plantings. Dr. Laura Jackson, Director of the Tallgrass Prairie Center and Professor of Biology at the University of Northern Iowa, told us that the commercial seed industry pays close attention to specifications, so when Iowa DOT specified local ecotype seed, it really helped to drive change within the industry. Oregon is currently redesigning its seed mixes to be ecoregionally specific, to accommodate the State's varying hydrology and climate. The use of local ecotype plant material not only increases the chances that a planting will establish successfully, it also ensures that plant material is well-adapted to the site. Pollinators that depend on flowering resources at specific times will benefit greatly from roadside plantings that use local ecotype plant materials.

Ohio has very little roadside remnant habitat that remains intact. Most roadsides in Ohio are predominately planted with nonnative cool-season grasses, but, Ohio has recently undertaken several roadside restoration projects using native plants. These plantings, led by Ohio DOT's Dianne Kahal-Berman in District 9, were undertaken expressly to provide pollinators with habitat. Kahal-Berman began the project after learning of pollinator declines. She told us that losing pollinators like bees was an unacceptable scenario, given the crucial role of pollinators to our food systems. Kahal-Berman felt that DOTs could play a key role in reversing declines by providing education to the public, generating excitement, and managing DOT land to support pollinators. Kahal-Berman began her project by locating sites for restoration that were not overtaken by invasive species and in areas that were very visible. She also sought out internal and external support, holding stakeholder meetings in the area to provide some education and engagement. Although the program is in beginning stages, she says that there has been great response, internally at Ohio DOT and from the public.

Several of the people we interviewed highlighted the multiple benefits of native species. Carmelita Nelson told us of a Minnesota DOT study that found that diversity in the vegetation helps to prevent driver drowsiness and safety. Bonnie Harper-Lore, a restoration ecologist now retired from the Federal Highway Administration (FHWA), told us of a handwritten letter received from a truck driver that thanked FHWA for all of the wildflowers along the road, to which he credited with keeping him awake throughout his long drives. Aesthetics and state natural heritages were advantages also mentioned by several transportation agency employees. Other personnel we interviewed brought up the importance of well-established native plantings in reducing invasions by noxious weeds, and providing habitat for pheasants and songbirds. Noting that erosion control is the primary reason for planting roadside vegetation, Harper-Lore highlighted native plant contributions to soil stabilization, and observed that plantings of native forbs and grasses form a matrix of vegetation that can hold even the steepest of slopes. Reduced runoff and improved water quality were other benefits of using native species that were brought up in the interviews.

Pollinators are more abundant and diverse on roadsides with native plants, but that is one of many benefits of using native plants in revegetation efforts. One of the restoration specialists we spoke with told us, “The fact that for so long a lot of DOTs have planted monocultures that need to be mowed all the time has really cost them lots of time and money. And if we can add native plants in rights-of-way, it will help every ecosystem.”

Constraints on Improving Roadside Habitat for Pollinators

Funding Constraints

The State DOT personnel we interviewed consistently mentioned that a lack of funding was a constraint to providing both IRVM as well as pollinator-friendly roadside management. DOT staff acknowledged that all DOTs are underfunded, and that the money they do have first goes to roads and bridges. “There is no money in landscape, so what would need to happen is specific funding dedicated to establishing native plants on the roadsides,” said one DOT representative. Another DOT representative told us that “the biggest overarching problem with this [IRVM] program is budget cuts and staff reductions, and the feeling that this is an optional program.” Few States have funding for roadside inventories. One DOT representative said that although they are certain that their State has remnant roadsides there are no resources to identify the remnant habitat.

Constraints to Reducing Mowing

In a few States we interviewed, intensive mowing is the primary method of managing most of their roadsides. Of the State transportation agencies we interviewed, Florida had the most intensified mowing program, with roadsides in some portions of the State that are mowed up to 20 times a year (equivalent to mowing a site about every 18 days). Roadsides that are mown so frequently would not support pollinators. Jeff Castor of Florida DOT has been pushing for change within his agency: “We did a research project that looked at the ecosystem services provided by the unpaved portions of the highway system, and benefit to pollinators was just one of the ecosystem services the landscape provided. The study indicated that if we reduced mowing, the ecosystem services would be greatly enhanced and we could get more benefit from it.” The study also found that Florida could save significant amounts of money by reducing mowing. Despite these positive findings, Florida DOT was extremely wary of reducing mowing. After some internal negotiation, everyone agreed to trial a 10 percent reduction in mowing. Although a 10 percent reduction translates to mowing some sites every 20 days rather than every 18 days, Castor thinks that this is a significant beginning.

Several of the transportation experts who were interviewed mentioned that some States are not open to simple changes like reduced mowing. The culture within the agency can play a role, based on the feedback we received from the DOT staff that we interviewed. A DOT representative said of the mowing within their state, “in my opinion 50 percent of mowing is ineffective and is a cost that should not be incurred but it happens because of lack of knowledge and expertise.” In some States, recommendations for mowing may come from the turf management programs at State universities, which encourage the DOT to fertilize and mow often to maintain the roadside as turf. Several people

interviewed voiced a need for guidance or directives from FHWA on reduced mowing, while others felt that directives were needed but would be most effective if they came from governors or local representatives.

Intensive mowing also occurs in urban areas within States that have reduced mowing in rural areas. Consistently, our interviewees mentioned that people in urban areas tend to tolerate wildflowers less than turf. Cathy Ford of Idaho Transportation Department told us that there was some pressure to maintain more manicured roadsides around cities, even in areas that received little rainfall. Wildflowers might be viewed acceptable as long as they are in bloom and kept tidy.

Another mowing-related issue in California, Iowa, and Minnesota is the mowing of roadsides for hay by landowners. Although Iowa and Minnesota road authorities have some restrictions in place on when roadsides can be mowed, citizens rarely conform to those regulations when haying. Haying might take place multiple times during a growing season, and Joy Williams of Iowa DOT, Tina Markeson of Minnesota DOT and Carmelita Nelson of Minnesota Department of Natural Resources all noted that such haying practices are likely to be very disruptive to pollinators as well as other wildlife.

Constraints on Timing of Mowing

Mowing was identified by multiple States as one of the biggest opportunity for changes to benefit pollinators (alongside the increased use of native wildflowers), as well as the biggest challenge. State DOT employees were open to the idea of receiving guidance about the best time to mow to benefit pollinators, but emphasized the need to have some flexibility about when to mow. Many pollinators, including monarch butterflies that migrate south in the fall, would benefit from mowing that takes place after the first frost. From the perspectives of our interviewees, there are downsides to this timing. For example, delaying mowing until the fall allows any weeds present during the growing season to go to seed. Iowa, Minnesota, and New York also stressed that postponing mowing until the fall would be difficult due to the approaching onset of winter. Joy Williams from Iowa DOT told us that the agency is in “winter mode” by October 15. Tina Markeson from Minnesota DOT said that the State’s delayed-mowing law already creates a sense of urgency among maintenance staff to get as much mowing done as possible in August. Carmelita Nelson reiterated that point, noting that if staff were told that mowing would have to be later than August, they would feel more pressure from also needing to get ready for winter. Mike Shippey of Oregon DOT also mentioned weather constraints in the fall, noting that although it would be the best time to mow from a natural resources perspective, the agency’s limited staff could not mow all the roadsides in the short window of time that the weather would allow.

Several restoration experts pointed out that mowing during the growing season, although it can be harmful to some pollinators, can also benefit pollinators by rejuvenating wildflower populations. “The reality is that it [a roadside] has to be mowed sometime. If it remains unmown year after year, they [roadsides] will grow into trees,” according to one roadside restoration expert we interviewed. Another reiterated the point, saying, “There is some benefit to mowing on roadsides because flowers will rebloom. If you don’t do any mowing, there will be fewer pollinators because there will be fewer flowers out there. Cutting back actually helps. If you are aiming for herbaceous species, you have to mow at least once a year to keep the woodies out.”

However, our interviewees also highlighted the difficulty in finding a time during the growing season to mow. “It has to be a compromise between birds, bunnies, and butterflies, and something is going to get killed,” said one roadside restoration expert. New York, Minnesota, and Iowa DOTs all currently aim to time their mowing to reduce impacts on birds and bats. A DOT representative said, “Pollinators are important, but this needs to be looked at holistically with the other things we are tasked to do. Like avoid mowing during bird nesting season or avoid this and avoid that. It gets complicated fast.” Another DOT representative underscored this idea as well, mentioning that scheduling work can be very difficult with competing regulations: “State law says we must use the most cost-effective or ecological control strategy [to maintain roadsides]. Well, that means if you use herbicides, they must be used when most effective, but then the endangered species law trumps that and we need to use something else at the wrong time of the year to get around that.”

These interviewees emphasized that although there are benefits to mowing laws that restrict timing, there are also unintended consequences. A restoration expert said that ultimately, when it comes to timing mowing to benefit wildlife, “there really is no one right good answer. You just have to do your best. It is a balancing act.”

Constraints on Modified Herbicide Use

Current practices of herbicide use by the DOTs we interviewed are likely harmful to some pollinators. Limited staff time was frequently cited as a constraint to applying herbicides in the most ecologically beneficial manner. Many DOTs use booms to apply herbicides, which increases the likelihood that nontarget vegetation (and as a consequence, pollinators) is impacted by applications. Tina Markeson of Minnesota DOT described the hose reels used for spraying for trucks, observing that Minnesota DOT’s definition of spot spraying was different than most: “We do spot spraying, but the spots are larger than if you are using a backpack. Our definition of a spot is 400sq ft.” Additionally, while States such as New York and Idaho work to time applications of herbicides to be most effective, staff and resource constraints mean that not all weeds are treated at the optimal time.

Very few of the States we interviewed provide their maintenance staff with training to identify native vegetation. A roadside restoration expert pointed out that as a consequence, “Road authorities can’t always tell what is what. If they see purple, they see thistle. They don’t know that it is a blazing star or some other good plant.” A DOT representative noted that native thistles, highly beneficial to pollinators, are often mistaken for invasive thistle species. Finding time, expertise, and resources for training were all mentioned as constraints to reducing herbicide use through the identification of native vegetation.

Constraints on Use of Native Plants

When asked to name management changes that they think would benefit pollinators the most, the people we interviewed most often cited increasing the use of native plants, as well as modifying mowing regimes. However, eight of nine State DOTs also identified the cost of native plant material as an obstacle. For example, Cathy Ford, Idaho Department of Transportation, told us that there are many native species that she cannot purchase because of costs of some wildflowers reach over \$100 a pound. With small budgets, Ford is only able to purchase a small amount of wildflower seed.

Firecracker penstemon and western prairie clover, wildflower species Ford mentioned that she'd like to use because they establish easily and are great for pollinators, are too expensive.

Availability of species is also an issue. For example, there is only one native seed vendor in Ohio, which limits the plant species available to Ohio DOT. In Idaho, Ford emphasized that there are many wildflowers she'd like to be able to use, such as native asters and milkweeds, that are not available in sufficient quantities. As a consequence, Ford has access to a limited subset of native wildflowers with a limited range in bloom times.

But even in States such as Minnesota where there are multiple seed vendors that can supply large quantities of many native species, cost appears to be restricting the use of native species in roadside plantings. According to Tina Markeson, the expense of native seed is one of the reasons why only 30 percent of new Minnesota DOT plantings use native vegetation. Designers and builders within the department feel the cost is too expensive to justify. If cost was not a factor, there would be more wildflowers, Markeson told us.

Bonnie Harper-Lore reiterated the constraints surrounding seed availability and costs. She mentioned two efforts she undertook while working at FHWA to attempt to increase seed supplies, including a legislative proposal to give no-interest loans to seed growers that ultimately did not pass, and a national conference to encourage seed growers to share workable strategies for increasing seed availability.

Additionally, the process of establishing native plants can be a barrier. New York DOT has little experience with the establishment of native wildflowers, although they are comfortable establishing native trees and shrubs. Their limited experience makes them hesitant to use native wildflowers in erosion projects or revegetation efforts. Similarly, Ohio has interest in establishing more roadside plantings using native plants, but does not yet feel comfortable with the establishment and maintenance processes.

Another limitation to increasing the use of native plants is the perception of native plants by the public. For example, one roadside restoration expert noted that "One of the limitations I see is many of these county roadsides are by farmland and you find roadside managers going through all the effort to get forbs out there. The farmers see the flowers as a threat so they go out and spray with herbicides." A DOT representative echoed that thought: "One of our biggest problems is selling the idea of using native plants on the roadsides to farmers. They are usually resistant especially if they can't hay that area as much." In contrast, another roadside restoration expert felt that farmers were more likely to be receptive to wildflowers in roadsides than people in urban areas, because they could see the direct value of having pollinator and beneficial insect habitat near their crops. In their experience, noted a restoration expert, "You have to make the financial and functional case as best you can, and some people will be receptive to that and others not."

Lack of Expertise

Six agencies highlighted deficiencies in knowledge within their agencies as examples of a lack of expertise to manage roadsides as a natural resource. Florida, for example, mentioned that Florida DOT does not employ any biologists, and in order to conduct roadside inventories, they must hire contractors. Though New York DOT has great experience with planting trees and shrubs, they do not have expertise when it comes to wildflower establishment. In Minnesota, there is a fairly large

knowledge gap in the ability of maintenance personnel to recognize the weed versus a beneficial wildflower, according to Carmelita Nelson. One DOT representative told us, “Our guys know how to mow but don’t have the knowledge of plant ID or cultivation. We don’t have landscape architects, horticulturists or botanists on staff.” According to Bonnie Harper-Lore, Ohio had trialed a project to plant native wildflowers about 15 years ago, but weren’t familiar enough with restoration and native species to recognize that they had purchased a species mix primarily composed of annual flowers with origins outside of Ohio, including species from Europe. As a result, the planting only lasted a single year, and the failure set back attempts to plant wildflowers in the State for some time.

In Florida, Dr. Jeff Norcini and Jeff Castor of Florida DOT provided another example of the impact a lack of expertise can have on roadside habitat and pollinators. The frosted elfin butterfly, an imperiled species, uses host plants in the bean family, and particularly prefers sundial lupines. In a right-of-way adjacent to Florida Forest Service land where both lupines and frosted elfin butterflies were present, the DOT agreed to suspend mowing until after the lupines present bloomed and dispersed seed, which usually occurs by June 1. After June 1, mowing resumed on a 30-day cycle, and as a result, the mowing caused severe soil compaction and suppressed other native plants. Although the frosted elfin had habitat during its flight period, the habitat quality for pollinators and other wildlife was highly diminished for the rest of the growing season. A natural resources contractor visited the site and recommended that the site could be restored by mowing the roadside only as necessary to prevent encroachment of woody vegetation and through regular monitoring and spot treatment of invasive species.

“I think there is a lack of expertise especially because there is a perception that this [roadside revegetation with native plants] is easy - just pull seed off the shelf and throw it on the ground. In reality, it is just like being an engineer, with training needed,” said a roadside restoration expert.

Overspray/Drift of Herbicides from Adjacent Land

Off-target herbicide applications can damage roadside plantings, which can reduce the habitat quality for pollinators and other wildlife and also increases opportunities for weeds to invade the planting, further decreasing its quality. Joy Williams of Iowa DOT explained that this type of damage can occur in roadsides adjacent to herbicide-resistant crops when boom sprayers are not turned off as sprayers turn around at the edges of fields in the process of applying herbicides. One roadside restoration expert with 25 years of experience in restoring and planting native wildflowers on roadsides, said, “I think in hindsight we should have focused on areas where it was not going to get sprayed. When the county put forth the projects wherever they wanted, the main criteria was they needed to have good habitat potential but in hindsight, I would say we need to focus on areas either adjacent to landowners yards where they will take care of it and not spray it, an organic farm, park or public area or even a church where the site will not be regularly sprayed. I feel like we wasted a lot of money by spreading our seed mixes, which are often 25 species or more, where the grasses lived but the flowers often get sprayed and only a few of them live.”

Tools Needed for Change

Increased Support within State Agencies, Support from FHWA, and Support from the Public

Transportation agency employees universally mentioned their need for increased support from within their agency and State, as well as from FHWA (“buy-in from top to bottom,” as one person said) to make roadsides more pollinator-friendly. All interviewed were interested in improving roadside habitat for pollinators, but also were thinking more broadly about the stewardship role of DOTs and managing roadsides as conservation lands. For example, several of the people we interviewed felt that environmental stewardship belonged in the mission statements of their agencies, as well as in FHWA’s mission statement.

Currently, natural resources are not a priority for State DOT agencies, according to the people we interviewed. The focus on safety and efficiency overshadows the natural resource value of roadsides, which receive little thought and few resources. One DOT representative said, “The main interest is pavement and getting people from here to there. Other things are incidental.” Other DOT representatives also expressed concern that ecological roadside management can be difficult to implement when crews are tied up with other priorities. Better coordination and communication between functional units is also necessary, said another DOT representative. “Environmental and Landscape Architecture divisions may implement a great planting, but if Maintenance is uninformed, the benefits may be lost.”

Because maintenance staffs perform a wide range of duties, several people interviewed suggested that specific staff be dedicated to the purpose of managing roadside vegetation. “For DOTs to do anything significant on their roadsides will require some way to empower them, and to separate [vegetation management] from their maintenance crews. The work is [currently] done by the same people that patch holes and fix cracks and everything else,” said a DOT representative. “In the priority of things, vegetation falls low on the priority list and it is hard to get the time and resources to do it well.” A roadside restoration expert told us, “I think you need to have people with biological backgrounds involved. It took us 10 years to get really comfortable with doing this work. I think if they have the biological sciences background, they can catch up pretty quickly.” Another roadside restoration expert agreed, saying “Having people dedicated to restoration on a permanent basis like we have would be a tremendous advantage. This is a highly specialized field, and a lot of agencies don’t have the time or resources to do it successfully.”

Some ideas proposed to increase support within DOTs include targeting plantings to improve success of restorations, increasing public support, and presenting data demonstrating the economic and ecological value. Restoration experts we spoke with encourage the DOTs they work with to seek out remnant roadsides that through reduced mowing and simple management can become spectacular sites. A roadside restoration expert told us, “It would take expertise to go out there and find areas with a high probability of success, but it is easier to teach ground staff how to manage those areas than go in and plant a new area. Any Federal initiative around that has the probability for success.” Additionally, restoration experts recommended that revegetation projects with native plants should be prioritized in areas with low to moderate weed pressure. Knowing that DOT staff typically have limited experience with restoration, they recommended deprioritizing work on sites that have high

weed pressure, because these sites may take more time and expense to convert back to native vegetation. Restoration experts also suggested focusing efforts on the widest rights-of-way possible to maximize potential habitat. Experts also highlighted the value of locating restorations in areas highly visible to the public, in order to increase awareness. “You need to use both the economic and ecological approach to make selling this program palatable to the public,” said one roadside restoration expert. “But there also have to be areas with showy plants to wow the people driving at 60-70 miles an hour for a program like this to be successful. The best PR is having the showy stuff: color sells!” Jeff Castor of Florida DOT mentioned that some of the counties in Florida adopting wildflower resolutions were doing so because it supported tourism. Positive feedback from the public can also increase support within DOTs. Chris Jannusch from California DOT suggested that having a system to prioritize the placement of plantings would be very useful. For example, placing new native plantings next to almond orchards might receive higher priority because of ecosystem service benefits than using native plants in a cloverleaf embedded in a densely populated urban area.

LeRoy Brady from Arizona DOT, John Rowen from New York DOT, and Scott Riley from Ohio DOT advised that internal support for pollinator conservation can be gained by highlighting the multiple benefits of using native plants. One DOT representative felt that proposing management changes based on benefits to pollinators was not enough: “Plants [to support pollinators] are a real benefit but are a component of an overall revegetation program to stabilize slopes to prevent erosion and reduce long term maintenance. You need to approach it from a point of how it benefits all aspects, and one of the important aspects is plants for pollinators.”

In addition to support from the public and from within their agencies, the people we spoke with wanted directives from government. Scott Riley from Ohio DOT thought that in order to move forward in a meaningful way with making changes, the governor of the State would need to be engaged. Dianne Kahal-Bermen from Ohio DOT agreed but added that she thought that protecting pollinators through roadside habitat should be a non-partisan effort. Several people mentioned that guidance from FHWA would be helpful to the States. “Their leadership will have a huge impact on the States. If FHWA really starts pushing forward the whole idea of biological corridors, all the sand and gravel guys will get in line,” one DOT representative told us. “If FHWA and FWS would start sending some strong messages to the DOTs around this, they would have a dramatic effect.” Another representative said, “If FHWA issued a mandate or developed policy around pollinators and roadside pollinator habitat, it would really help us improve coordination between the design and environmental stages and maintenance.” Multiple DOT representatives mentioned that current Federal funding was too low to support the planting of wildflowers. When asked about this, a roadside restoration expert said, “There is a requirement that they plant native wildflowers but it is such a small percentage of their budget [at a minimum 0.25 percent of the funds expended for landscaping] that it is almost meaningless. If they had to plant half of their erosion control landscaping control budget with native plants, that would get their attention. Suddenly, they would have to find the expertise to make it happen.”

More Education and Training

Education and training were also universally mentioned as indispensable by transportation agency employees. The people we interviewed expressed a need for information in five areas:

1. Native plant identification,

2. Native plant establishment and management,
3. Affordable, ecoregional species lists of plants that support pollinators,
4. Importance of pollinators and their habitat needs, and
5. Examples of targeted management changes to benefit pollinators.

Native plant identification was requested, alongside noxious and invasive species identification. Carmelita Nelson suggested that posters that can be hung in maintenance shops, and pocket guides that can be stowed in trucks or tractors can be effective tools. Dr. Laura Jackson proposed using YouTube videos for education, but thought that ultimately, hands-on experience in the field is the most important. Dr. Jeff Norcini also proposed signage in wildflower areas to remind mowers to be careful.

People also acknowledged that they were in need of information about native plant establishment and management. Scott Lucas of Ohio DOT admitted that they don't have the internal expertise to establish and maintain native plantings on large scales. Lucas suggested that they might look into partnering with another organization that has experience (e.g., Pheasants Forever), so that his staff could work alongside their experts to learn and use it as a training period. Restoration ecologists underscored the value of training. One roadside restoration expert said, "Just because these are wildflowers does not mean they don't need work until well-established. Training is critical." Another roadside restoration expert told us, "You really need to understand what you're working with. You need to understand the climate, the soils, and the vegetation. It does take time and money to figure it out but is doable. We have a process that we follow." Another roadside restoration expert concurred, offering insights and tips for successful projects: "One of the things our team does is get involved with these projects two to three years before they are implemented. This allows us to collect seed, propagate, do soil surveys, look at the climate and work with the engineers to change plans. A lot of times when we do our initial study of a site, we often go back to the engineers and let them know what we foresee as challenges so we can try and approach it from a different angle. Timeframe is really important. You need to have a minimum of a year to plan how to develop the site for it to be successful. One of the reasons for our success is having support top-to-bottom internally and from our funding sources that give us the ability to successfully implement projects we are involved with. The other thing that helps our success is one of us from the team being at the site during installation to ensure guidelines are followed. There is a lot of labor and love that goes into this."

Guides to affordable, ecoregional species lists of plants that support pollinators were highlighted as tools that would be useful. Cathy Ford of Idaho Transportation Department requested plant lists of commercially available species that include plant attributes, functional roles, and value to pollinators. Ecoregional lists of plants that could be used by DOTs would also be useful for farmers, gardeners, and restorationists.

In order to understand the changes they are implementing, and justification for those changes, DOT representatives requested more information about the importance of pollinators and their habitat needs. They wanted to know more about the benefits of pollinators to agriculture for their own knowledge, and also to help sell their vegetation management programs. Joy Williams of Iowa DOT added that information about imperiled or listed species that might be present on roadsides would be useful, including their flight times and habitat needs. Oregon DOT's Mike Shippey went a step

further and suggested that if imperiled pollinators are utilizing roadside habitat, staff need proper training on managing those areas where the pollinators reside.

Finally, people were interested in having concrete examples of targeted management changes that could benefit pollinators. Sample mowing regimes were one example put forth. Another person requested that this current project's findings be incorporated into a webinar for transportation agencies.

Interviewees recommended that training and education on these topics should be available for the maintenance staff, design staff, engineers, and middle management of State transportation agencies. Many of the interviewees proposed that trainings should include other experts and state and federal land managing agencies that could share their knowledge and expertise. "We are interested in looking at the land management practices that other State agencies and private land owners are using. We feel doing so would be beneficial to the department and everybody," one DOT representative told us. Additionally, everyone we spoke with was eager to connect with other peers. For example, another DOT representative said, "It would be very helpful to hear what nearby States have to say about these and the issues they are facing. Understanding what they are doing helps us in dealing with what we are up against." Another DOT representative mentioned that at one point in their career, FHWA paid for travel for peer reviews of vegetation management programs, and they felt that exposure to the "tremendous amount of experience" of peers in nearby States was highly beneficial. Similarly, another DOT representative noted interest in learning from others: "I'm very interested in seeing what other States are doing and what is working for them in regards to pollinator habitat."

Expanding Seed Markets

When asked if there were any additional thoughts they'd like to share about managing roadsides for pollinators, several of the people we spoke with mentioned concerns about native seed availability. Specifically, they were concerned about matching native seed to ecoregions. Before the State of Iowa put in place local ecotype seed specifications, Dr. Laura Jackson said there were "Wild West" conditions, where seed was procured without regard to its origin. Jackson is concerned that as the use of native wildflowers in roadside plantings increases in other States, the benefits of acquiring local ecotype seed will be overlooked in favor of cost savings. It would be a tragedy to miss out on the opportunity to capture local genetic variability, Jackson told us, and that opportunity shouldn't be overlooked even if seed from other regions can be obtained much more cheaply. Bonnie Harper-Lore used milkweed seeds being shipped around the country to illustrate her concern. She noted that milkweed seeds from one region are being planted in different regions, with two possible and undesirable outcomes. Some won't be able to successfully establish and those plantings will fail, but others might succeed to such an extent that they become invasive and problematic. Planting ecoregional seed sources is critical to creating successful plantings and avoiding unintended consequences. One DOT representative proposed that Operation Wildflowers, a cooperative program between Garden Clubs, State agencies, and FHWA, might be a creative way to gain ecoregional foundation seed that could be used by DOTs or private partners to amplify seed. The use of ecoregional seed improves establishment success and is more beneficial to pollinators.

Chapter 3

Final Thoughts

All of the individuals we spoke with are passionate about their jobs and about the value of roadsides in the landscape. They have an interest in pollinators and in managing roadsides with pollinators in mind, but require certain tools to implement positive changes. These last two quotes highlight the key findings from our interviews:

“Growing native plants on roadsides needs to be routine.”

-- A roadside restoration expert

“Roadsides have historically been managed as a utility rather than as a natural resource. We maintained roadsides to keep nature from encroaching, thinking that roadsides are incompatible with functioning habitat and corridors for wildlife. But we know now that it can be done.”

-- A DOT representative

Appendix A

Survey Questions Distributed to the State Department of Transportation Personnel Interviewed for this Project

General policies and procedures for right of way (ROW) management

1. Is an integrated roadside vegetation management program (IRVM) used in your transportation agency?

If the answer is yes:

- 1a. Is the IRVM program mandated by policy?
- 1b. Is there an organized training program to support IRVM?
- 1c. Is roadside vegetation management site-specific? (i.e., are different management techniques used in different areas to address site-specific problems?)
- 1d. Has your agency developed best management practices for your IRVM program?

If the answer is no:

- 1a. Has your agency developed best management practices for roadside vegetation management?
- 1b. Has there been any discussion or actions taken towards the development of an IRVM program?

2. What roadside management tools does your agency use most? Please rank the following roadside management tools in order from most used to least, and estimate the percent of ROW that the tools are practiced on:

- ___ Mowing: ___%
- ___ Herbicide use: ___%
- ___ Grazing: ___%
- ___ Fire: ___%
- ___ Hand cutting or removal of brush: ___%
- ___ Biological control: ___%
- ___ Native vegetation: ___%
- ___ Other: ___%

3. In areas where mowing may be required are the entire roadside ROWs mowed (as opposed to regular mowing of the shoulder and/or intersection for visibility)?

If the answer is yes:

- 3a. How often does mowing take place and when does mowing take place during the year?
- 3b. Do you have any existing mowing exceptions to protect sensitive native plants or to avoid spreading invasive species?

4. How frequently are herbicides used, and under what circumstances are they used?

- 4a. Are broad-spectrum herbicides typically used?

- 4b. Are herbicides primarily applied through using a boom, by aerial spraying or via spot treatment?
- 4c. Are applications timed for optimal control of specific target weeds?
5. Do you ever use insecticides as part of your roadside management program?
6. Are there any chemicals used for road maintenance (e.g., road salts) used by your agency that could harm pollinators?
7. What is the average cost of maintenance per acre of roadside in your state?
- 7a. Do you calculate cost per method? If so, please estimate the average costs for the methods below.
- Mowing: ____
- Herbicide use: ____
- Grazing: ____
- Fire: ____
- Hand cutting or removal of brush: ____
- Biological control: ____
- Native vegetation: ____
- Other: ____
8. When revegetating a roadside, is it a priority to use native plant species rather than introduced plant species?
- If the answer is yes:*
- What percentage of new roadside plantings incorporate native plant species?
- If the answer is no:*
- Would your agency consider increasing the use of native plant material in roadside revegetations? Why or why not?
9. Is grazing used by your agency? If so, how often, on average, are roadsides grazed during a year, and in what season/s does the grazing typically occur?
- If grazing is used:*
- 9a. What species of grazer are you using for roadside grazing?
- 9b. Is grazing used for invasive plant control, and if so, which invasive species?
10. Is prescribed burning used by your agency? If so, how often, on average, are roadsides burned during a year, and in what season/s are burn/s undertaken?
- If burning is used:*
- 10a. As part of your burning procedures, what method do you use to contain a fire?
- 10b. If your agency uses a fire break, what is the average size of the fire break?
- Current management practices that can benefit pollinators*
11. Does your agency make any adjustments to manage roadsides for pollinators in general?

12. Does your agency adjust management practices to avoid impacting imperiled invertebrate species (listed or unlisted species) such as the monarch butterfly, the Karner blue butterfly, or the rusty patched bumble bee?

Opportunities and constraints for pollinator-specific roadside management practices

13. Are you aware of any state or local laws that mandate pollinator habitat protection? If so, please elaborate.

14. Reducing the frequency of mowing per year is generally beneficial for invertebrate pollinators. Would it be practical for your agency to consider limiting mowing to one to two cuts per year? Why or why not?

15. If your agency were to mow only once or twice per year, what time of the year would the mowing take place and why?

16. If your agency already has a reduced mowing policy (e.g., a policy to delay mowing to accommodate nesting birds), do you think timing could be adjusted to also benefit pollinators (e.g., delayed until after first frost)?

17. Does your agency currently offer training on native and invasive plant identification alongside herbicide application training?

18. If prescribed fire is a tool you or your agency uses, would you/your agency consider the use of rotational burning on portions of roadsides, leaving unburned refuges?

19. If grazing is a tool used by you or your agency to manage roadside vegetation, would you/your agency consider implementing the following grazing practices: limiting the stocking density of grazers, leaving long rest periods, and timing grazing to avoid damage to imperiled pollinators? Why or why not?

Increasing the value of new roadside plantings to pollinators: opportunities and constraints

20. If native wildflowers are currently included in new seed mixes, do the mixes contain species that overlap in bloom time so that there are floral resources available to pollinators throughout the growing season?

21. In addition to native wildflowers, there are many native flowering shrubs that support pollinators. How frequently are native flowering shrubs planted or included in the seed mix in ROWs?

21a. If flowering shrubs are included in new plantings, how are motorist safety concerns addressed?

22. What percentage or proportion of grasses are typically used in seed mixes for new roadside seed mixes, compared to wildflowers?

23. Are regionally sourced native plant materials readily available to your DOT?

If the answer is no:

23a. If seeds of native plants are limited in your state or region, what steps might be taken to increase availability?

23b. Do you think working with private nurseries and volunteers to obtain locally sourced seeds has potential in your state?

24. Is the cost of native plant material an obstacle at your DOT?

General questions

25. What roadside management changes do you think will benefit pollinators the most?

26. What do you see as potential limitations to implementing pollinator-friendly management practices on roadsides?

27. Do you think that pollinator conservation measures along roadsides are compatible with driver safety? If not, what steps could be taken to improve driver safety?

28. What types of training do you believe might be useful for roadside managers to aid in the implementation of pollinator-friendly roadside management?

29. If there are studies or documents that you consider to be useful guides or BMPs for IRVM programs, please identify them for us.

30. If you are aware of case studies or examples of successful roadside vegetation management approaches that benefit pollinators, please describe them for us.

31. Is there any additional information that relates to roadside management for pollinators that you would like to share with us?

Appendix B

Survey Questions Distributed to Roadside Restoration Experts Interviewed for this Project

1. What roadside management changes do you think will benefit pollinators the most?
2. What do you see as potential benefits to implementing pollinator-friendly management practices on roadsides?
3. What do you see as potential limitations to implementing pollinator-friendly management practices on roadsides?
4. How might the limitations you describe be overcome?
5. Are there agency partnerships, either state or federal, that would increase the success of pollinator friendly roadside management efforts?
6. In your opinion, does your state transportation agency currently have an interest in protecting pollinators by increasing the habitat quality of roadsides for pollinators?

If the answer is yes:

What measures are you aware of that your state transportation agency has taken, or is planning on taking, to increase the value of roadside habitat for pollinators?

If the answer is no:

6a. What would it take to increase their interest and encourage them to implement changes?

6b. Please rank the following from 1-4 (1 highest, 4 lowest) in terms of information that you believe would be most likely to encourage implementation of pollinator-friendly practices:

_____ Evidence of the value of roadside habitat to pollinators

_____ Evidence of the value of pollinators to agriculture,

_____ Evidence of the value of pollinators to ecosystem health

_____ Evidence of the economic value of pollinator-friendly roadside management

7. Do you think the general public would support pollinator friendly roadside management (e.g., roadside plantings that take several years to establish; reduced mowing/turfgrass appearance)? Why or why not?
8. What types of training do you see as beneficial to roadside managers or transportation agency staff to aid in the implementation of pollinator-friendly roadside management?
9. Please rank the following management strategies that can benefit pollinators according to feasibility (in your opinion) of implementation in your state, and include a brief explanation about your selection.

<u>Feasibility</u>	<u>Practice</u>
High / Medium / Low	Limiting mowing (one to two cuts per growing season)
High / Medium / Low	Spot herbicide treatment
High / Medium / Low	Plant identification training for roadside managers
High / Medium / Low	Increased communication with local experts about imperiled pollinators and their habitat needs
High / Medium / Low	Rotational prescribed fire, with refuges
High / Medium / Low	Limited, site-specific grazing
High / Medium / Low	Increased use of native plants
High / Medium / Low	Increased density of wildflowers in seed mixes
High / Medium / Low	Signage indicating pollinator-friendly roadsides (or other public education efforts)
High / Medium / Low	Other:

10. Do you think that the use of native plant material in roadside revegetations can be increased in your state? Why or why not?
11. Are regionally sourced native plant materials available to your state transportation agency? Is the cost of native plant material an obstacle?
12. If seeds of native plants are limited in your state or region, what steps might be taken to increase availability?
13. Do you think that pollinator conservation measures along roadsides are compatible with driver safety?
 - If the answer is yes:*
 - Do you think that there is a perception that reduced mowing of entire ROWs leads to a decrease in driver safety?
 - If the answer is no:*
 - What steps could be taken to improve driver safety while also improving roadside habitat for pollinators?
14. Are there studies or documents that you consider to be useful guides or BMPs for integrated roadside vegetation management programs? If so, please identify them for us.
15. Have you been involved with, or are aware of case studies or examples of successful roadside vegetation management approaches that protect pollinators? If so, please describe them for us.
16. Do you think there are opportunities within your state to improve roadside habitat for pollinators? If so, please describe these opportunities.
17. Do you think there are opportunities on a national level to improve roadside habitat for pollinators? If so, please describe these opportunities.

18. Is there any additional information that relates to roadside management for pollinators that you would like to share with us?

Appendix C

State Department of Transportation Staff Interviewed for this Project

State DOT	Interview Participants	Position
Arizona	E. LeRoy Brady	Manager/Chief Landscape Architect
	Justin White	Roadsides Resources Manager
California	Jack Broadbent	Division of Design, HQ Landscape Architecture Program
	Christopher Jannusch	Biologist, Associate Environmental Planner
	Kenneth Murray	Senior Landscape Architect
Florida	Jeff Caster	State Transportation Landscape Architect
	Ashley Binder	Landscape Architect
Idaho	Cathy Ford	Roadside Program Administrator
Iowa	Mark Masteller	Chief Landscape Architect, Office of Design
	Troy Siefert	Living Roadway Trust Fund Coordinator, IRVM Program Coordinator
	Joy Williams	Agronomist, Office of Design
Ohio	Dianne Kahal-Berman	District 9 Project Manager
	Scott Lucus	Head of Operations Maintenance
Oregon	Michael Shippey	Landscape Architect, Statewide Roadside Development and Botany Program Coordinator
Minnesota	Ken Graeve	Roadside Vegetation Management Unit
	Tina Markeson	Roadside Vegetation Management Unit Supervisor
New York	Peter Dunleavy	Associate Landscape Architect
	John Rowen	Vegetation and Environmental Program Manager for Office of Transportation Maintenance
	Kyle Williams	Operations Environmental Coordinator

Appendix D

Roadside Restoration Experts Interviewed for this Project

Expert	Position
Kelly Evans	Botanist, United States Forest Service
Bonnie Harper-Lore	Retired, Restoration Ecologist, Federal Highway Administration
Dr. Laura Jackson	Director, Tallgrass Prairie Center, Professor of Biology at University of Northern Iowa
Carmelita Nelson	Former Roadsides for Wildlife Coordinator, Minnesota Department of Natural Resources
Dr. Jeff Norcini	Extension Specialist, University of Florida; Ecological and Horticultural Consultant
Scott Riley	Botanist and Regional Restoration Specialist, United States Forest Service
David Steinfeld	Retired, Revegetation Specialist, United States Forest Service