

# Roadside Habitat for Monarchs

## Frequently Asked Questions: Monarchs and Roadsides



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# Monarch Butterflies and Roadsides

## ***How does roadside vegetation support monarchs?***

Milkweed on roadsides is readily used by adult monarchs who seek out milkweed stems and leaves to lay their eggs on and nectar on milkweed flowers. Monarch larvae, or caterpillars, eat the leaves of many different species of milkweeds that grow in roadside areas. Roadsides can also provide diverse nectar sources which fuel adult flight, breeding, migration, and overwintering. Furthermore, roadside habitats may serve as important habitat corridors, can provide millions of acres of monarch habitat nationwide, and can be especially important in areas devoid of natural habitat (e.g., agriculture and cities). *Sources: Kasten et al. 2016; Pitman et al. 2018; Cariveau et al. 2019; Kaul & Wilsey 2019; Schacht & Wu-Smart 2019; Grant et al. 2020*

## ***Which types of roadside vegetation support monarchs?***

Adult monarchs feed on nectar from a variety of blooming plants, including wildflowers and shrubs, while caterpillars feed on milkweed plants. Roadsides with diverse, flowering vegetation provide habitat for monarchs during their breeding and migration periods. For example, fall-blooming flowers can be especially important to migrating monarchs, which need large quantities of nectar to generate the fat reserves that enable them to complete their long-distance migration to overwintering grounds and survive winter. *Sources: Cariveau et al. 2019; Western Monarch Milkweed Mapper 2019; Schacht & Wu-Smart 2019*

## ***Do monarchs reproduce on roadsides?***

Yes. Monarchs use milkweed on roadsides for reproduction—eggs, caterpillars, chrysalises, and adults have all been observed utilizing roadside habitat. Studies and monitoring efforts in the US Midwest, Southern Plains, West, and other areas have documented monarchs' use of roadsides for reproduction. *Sources: Mueller & Baum 2014; Kasten et al. 2016; Pitman et al. 2018; Western Monarch Milkweed Mapper 2019; Cariveau et al. 2019; Grant et al. 2020*

## ***Are there tools available for roadside managers to monitor milkweeds and/or monarchs on roadsides?***

Yes, a rapid field assessment for milkweeds, nectar plants, and monarchs can be found on the [Roadside Habitat for Monarchs](#) website. Another option is the Rights-of-Way as Habitat Working Group's [Pollinator Habitat Scorecard](#). The Scorecard can be used to monitor pollinators (including monarchs) and vegetation on transportation and energy lands. Lastly, the national [Integrated Monarch Monitoring Program](#) compares habitat and use by monarchs across different land-use types, including roadsides. This program is more quantitative and may be more rigorous when comparing different habitat types or regions across time. Read more about the program differences in a [comparison here](#).

## ***Does roadside vegetation that supports monarch butterflies also support pollinators and other beneficial insects?***

Yes! Roadside vegetation that supports monarchs also supports a wide range of insects, including butterflies, bees, flies, wasps, beetles, and more. Roadsides with diverse, flowering vegetation can serve as foraging habitat, provide a place to breed, nest, or overwinter, and help pollinators and other insects to move through landscapes by linking fragmented habitats.

*Sources: Dirig and Cryan 1991; Munguira and Thomas 1992; Ries et al. 2001; Saarinen et al. 2005; Hopwood 2008; Schaffers et al. 2012*

## ***Does monarch-friendly roadside vegetation provide any advantages to adjacent landowners?***

Yes, habitat on roadsides can help maintain healthy ecosystems and provide ecological services, such as crop pollination or crop pest suppression. Habitat increases the diversity and stability of the pollinator

community, and when on or near farms, habitat can improve pollination and increase crop yields. Roadside habitat also supports the beneficial insects that are predators of crop pests and contribute to natural pest control. In addition, roadside habitat can provide other ecological benefits that can translate to advantages to adjacent landowners, including reducing soil loss and water runoff, increasing water filtration and carbon sequestration, and supporting grassland birds. *Sources: Mader et al. 2014; Morandin and Winston 2006; Morandin and Kremen 2013; Varchola and Dunn 1999; Losey and Vaughan 2003; Harrison 2014*

## **Threats to Monarchs Associated with Roads**

### ***Are monarchs killed by collisions with vehicles?***

Yes, like many other animals and pollinators, monarch butterflies are killed by vehicles on roads. Existing research suggests that the greatest risk for vehicle-related monarch mortality occurs during the fall migration. For instance, researchers estimate that up to 20,000,000 monarchs were killed in Illinois during the 1998 fall migration. Another study estimates that 1-3 million monarchs are killed during the fall migration each year in the southern migration corridor (Oklahoma to Mexico), as the population's migration concentrates closer to the overwintering sites. A study in northeastern Mexico estimated 196,500 individuals killed at two highway crossing spots during October 15-November 11, 2018 (approximately 2 million per year). Despite this mortality, roadsides serve as quality breeding and foraging habitat for monarchs and in many locations, it is likely that there are more monarchs produced on roadsides than killed by vehicles (though further studies are needed on this topic). Roadside habitats not only have the potential to provide millions of acres of habitat nationwide but also play a role in connecting existing pieces of high-quality habitat. Additional surveys will improve our understanding of the variation in monarch road mortality within and among seasons, and to identify roadkill hotspots. *Sources: McKenna et al. 2001; Munoz et al. 2015; Keilsohn et al. 2018; Kantola et al. 2019; Alvarez et al. 2019; Phillips et al. 2020; Campioni et al. 2022*

### ***If roadsides have high quality monarch habitat, will that increase collisions of monarchs with cars?***

No studies have examined this with monarch butterflies specifically, but research involving other butterfly species suggests that more diverse roadside habitat, and roadsides with less frequent mowing are associated with reduced butterfly mortality, perhaps because butterflies are better able to find resources within the roadside habitat and are less pressured to cross the road in search of additional habitat. This research suggests that, rather than luring butterflies to areas where they are killed by vehicles more frequently, roadsides with high quality habitat reduces butterfly mortality compared with grassy, low diversity roadsides. *Sources: Munguira and Thomas 1992; Ries et al. 2001; Skórka et al. 2013; Halbritter et al. 2015; Phillips et al. 2020*

### ***Do vehicle collisions with monarch butterflies increase during migration, and is there any way to prevent roadkill?***

Data are limited, but it appears that more monarchs are killed due to vehicle collisions during fall migration compared to other parts of their migratory cycle. In Illinois, monarch mortality due to vehicles peaked during fall migration. In Texas, when monarchs funnel through the state on their way to overwintering grounds in Mexico, researchers found hotspots of mortality due to vehicle collisions. Roadkill hotspots occurred in less densely populated areas and sites with a more arid climate. The researchers suggest that migrating monarchs may spend more time flying lower to the ground during the afternoon in desert areas to seek shelter from the heat and may need to search more for nectar sources. Studies in northeastern Mexico have identified similar mortality results at two highway crossings during fall migration. Potential mitigation strategies for reducing monarch roadkill on recurring hotspots in Texas and Mexico are under investigation but may include reduced vehicle speeds, deflection structures to raise

the height of crossing monarchs, and manipulation of habitat to lower the potential for monarchs descending to roost near key crossing points. Sources: McKenna et al. 2001; Kantola et al. 2019; Alvarez et al. 2019

### ***Does roadside runoff, including heavy metal deposition and road salt deposition, affect monarchs and milkweeds?***

Studies have shown that roadsides can suffer from heavy metal accumulation from car wear-and-tear and residual leaded gasoline emissions. In northern states, sodium from road salt application can accumulate along roadsides, and exhaust emissions can elevate levels of nitrogen. While these chemicals can make their way into the leaves and nectar of plants growing next to the road, research suggests that the concentrations of plant toxins are typically not lethal to pollinators. Studies to date suggest that toxic levels of metals, sodium, and other roadside pollutants are most worrisome along very high traffic volume roads and just adjacent to the roadside. Thus, prioritizing habitat enhancement and restoration along low- or medium-traffic volume roads, and keeping a mowed buffer adjacent to the roadside, will likely avoid negative effects of roadside toxins on milkweed and monarchs. Sources: Snell-Rood et al. 2014; Mitchell et al. 2020; Phillips et al. 2020; Shephard et al. 2020; Phillips et al. 2021; Shephard et al. 2021

### ***How does road noise affect monarch caterpillars?***

Recent studies suggest that highway noise may negatively affect developing larvae. One study found that exposure to wasp buzzing decreased larval development time and pupal weight. The authors argue that because wasp wing noise is similar to road noise, the long-term fitness and survival of monarchs may be reduced in airports or roadside environments. A second study found that monarch larvae experienced significant increases in heart rate when exposed to simulated highway noise for a two-hour period. However, those that were exposed continuously for 7-12 days did not experience elevated heart rates at the end of larval development. Thus, the researchers suggest that larvae may become desensitized or accustomed to the noise with constant exposure. Sources: Davis et al. 2018; Lee et al. 2021

## **Milkweeds on Roadsides**

### ***What milkweeds are most common on roadsides?***

The answer to this question depends on what part of the country you are in. There are over 70 species of milkweeds native to the United States, but none of them occur in every state. To help roadside managers and others recognize milkweeds in their regions, we have developed milkweed recognition guides for 16 regions of the lower 48 states, [found here](#).

### ***How do I know if milkweed is on my roadside? / How can roadside managers recognize it?***

We have created recognition guides to help you to recognize the milkweed species that are most common on roadsides in your area, [found here](#). Most milkweeds have milky sap, so if you see a plant that looks like one of those in the guide to your region and milky sap oozes from the plant after breaking a leaf or stem, this is an indicator that you might be looking at a milkweed (though there are a few other types of plants, such as dogbane and spurge, which also have milky sap). Most milkweeds also have distinctive star shaped flowers that cluster together at the top of the plants. Then, when flowering is done, most milkweeds produce seed pods that open to release brown seeds with white fluff attached (the fluff helps those seeds travel on the wind). There are a variety of factors (height, leaf shape, leaf arrangement, flower color, etc.) to help one distinguish among the different milkweed species—or even to recognize dried milkweed stems in the fall and winter. Additionally, some milkweed species are only found in certain soils. If you are seeking information beyond what is found in the recognition fact sheets, see [Milkweeds: A Conservation](#)

### ***Are milkweeds in roadsides likely to spread to adjacent land and become weeds?***

Although milkweed, the common name for plants in the genus *Asclepias*, implies that the plants are indeed weeds, milkweeds are a diverse group of native wildflowers that are not listed as noxious weeds at either the state or the federal level in the United States. Milkweeds may have been perceived as weeds historically because a few species (out of the 70+ species in the U.S.) will readily colonize disturbed areas. These species tend to reproduce vegetatively (in addition to reproduction by seed), sending up new shoots from roots that spread outward from the parent plant. This clonal reproduction allows their populations to expand over time, and plants may spread out of their original area. Common milkweed (*Asclepias syriaca*) exhibits the highest degree of clonal reproduction, and vegetative growth also occurs to a lesser degree in horsetail milkweed (*A. subverticillata*), narrowleaf milkweed (*A. fascicularis*), plains milkweed (*A. pumila*), prairie milkweed (*A. sullivantii*), showy milkweed (*A. speciosa*), and whorled milkweed (*A. verticillata*). Despite the vegetative growth, many of these species are unlikely to create an ongoing and unmanageable weed problem for roadside managers (or adjacent landowners, other land managers, homeowners, etc.). Sources: *Borders and Lee-Mader 2014*

### ***Are milkweeds in roadsides a concern for grazing animals on adjacent land?***

Milkweed species present in roadsides are unlikely to be a threat to livestock on adjacent property. Very few milkweed species will spread from their planting site. If milkweeds are present in pastures or rangelands, most livestock take care to avoid them. Although milkweeds are toxic, livestock generally find them highly unpalatable. Poisoning events are rare—but not unheard of—possibly because livestock must consume a large amount of milkweed to become sick or die. An average cow weighing roughly 1,200 lbs would need to eat 12 lbs or more (1-2% of their body weight) of dried milkweed on average to die. Milkweed poisoning typically only occurs when livestock are confined to a barren paddock with no alternate food sources or when hungry animals are released into milkweed patches. However, there are two species, western whorled milkweed (*A. subverticillata*) and narrowleaf milkweed (*A. fascicularis*) which have been reported as especially problematic for cattle and sheep, likely because of their growth forms and thin stems and leaves which are easily tangled in grasses and thus difficult for grazing animals to separate out. It is also important to note that the palatability of milkweed increases when it is dry. If adjacent landowners are haying the roadside, it is best to avoid haying areas where concentrations of milkweed are high. Sources: *Panter et al. 2011; Burrows and Tyrl 2007; DiTomaso and Healy 2007; Schultz 2003; Malcolm 1991; Kingsbury 1964; Fleming 1920*

### ***Are milkweeds in roadsides that are hayed by adjacent landowners a risk to livestock?***

The palatability of milkweed increases when it is dry and so it is more likely that livestock will be sickened or even die from consuming dried milkweed in great enough quantities than fresh milkweed. If adjacent landowners are haying the roadside, it is best to avoid haying areas where concentrations of milkweed are high. However, large quantities of milkweed need to be ingested in order to cause harm. For example, an average cow weighing roughly 1,200 lbs would need to eat 12 lbs or more (1-2% of their body weight) of dried milkweed on average to die. The toxicity of milkweed varies by species and cardenolide concentrations (as well as local growing conditions); some species are generally of very low risk to livestock (e.g., butterfly milkweed, *Asclepias tuberosa*) while others are consistently quite high (e.g., woollypod milkweed, *A. eriocarpa*). Sources: *Burrows and Tyrl 2007; DiTomaso and Healy 2007; Schultz 2003; Malcolm 1991; Kingsbury 1964; Fleming 1920*

### ***How do milkweeds support pollinators or beneficial insects?***

Besides providing food for monarch caterpillars and adults, milkweeds support a wide range of pollinators

and beneficial insect species. Milkweed flowers are a high-quality nectar source for pollinators such as bees, butterflies, wasps, beetles, flies, and more. Milkweeds also attract a wide range of insects that contribute to crop pest control, and some producers (e.g., vineyards in the Pacific Northwest) have begun to integrate milkweeds into their agricultural system to attract these important insects and support biological control. Milkweed leaves, stems, and roots support insect herbivores such as other lepidoptera (butterfly and moth) species, wasps, flies, beetles, true bugs, and more. Milkweed “silk” (the fibers attached to the seeds and help the seeds catch the wind) can be used for nesting materials by vertebrates such as birds and small mammals.

*Sources: Tilman and Carpenter 2014; Borders and Lee-Mader 2014; James et al. 2016*

### ***What times of the year are milkweeds most readily observed in roadsides?***

In all of the lower 48 states, most milkweed species will be observable during the growing season. The months during which you can most readily observe milkweeds depend somewhat on where you are. In much of the northern half of the country, the best months to see milkweeds on roadsides are from July to August. However, in Texas and southern Oklahoma, green antelopehorn and spider milkweed (*Asclepias viridis* and *A. asperula*) emerge in March and are extremely important in that they help sustain the first generation of monarchs produced in the U.S. each year. Interestingly, in those two states, it can be difficult to find milkweeds in midsummer, as some of the most abundant milkweed species go dormant then; milkweeds can become abundant again in late summer or fall when conditions are more favorable. In the Desert Southwest, there are some native milkweeds that remain green during the late fall and winter. The same is true in the southeastern coastal plain with regards to a wetland species, aquatic milkweed (*A. perennis*), which can be found along roadsides in winter in eastern TX (and presumably in other places along the Gulf Coast that have warm winters).

### ***How can roadside managers share information about the occurrence of milkweeds and monarchs in roadsides to improve understanding of habitat conservation?***

- Set up a survey of monarch habitat and monarchs in your road system using the [Roadside Monarch Habitat Evaluator](#) or the [Pollinator Habitat Scorecard](#). Share findings at statewide and regional meetings, such as via the Rights-of-Way as Habitat Working Group.
- Designate a staff member as point person for milkweeds and monarchs who can answer questions and be a liaison between roadside managers, administration, state monarch efforts, and conservation organizations. In your local, regional, or state jurisdiction, include milkweed and/or monarch sightings and location maps to the list of communications and reports that are shared among staff.
- Add milkweed and monarch sightings to community science portals such as [Journey North](#) (North America) and/or the [Western Monarch Milkweed Mapper](#) (western US). Monitoring data can also be uploaded to the [Rights-of-Way as Habitat Geospatial Database](#), a tool used to store and track information about habitat restoration projects and conservation measures on rights-of-way lands.

## **Roadside Management for Monarchs**

### ***How can roadside vegetation inventories benefit monarchs?***

A roadside vegetation inventory involves mapping the composition and condition of current roadside vegetation, including native, invasive, and noxious weeds. Such inventories can inform management plans that can benefit monarchs in several ways:

- Identification of remnant habitat can allow roadside managers to make informed decisions about how to manage remnant habitat to maintain and improve it, to help sensitive plant species survive and



sustain habitat for monarchs and other wildlife.

- Roadside inventories can also be used to map out existing weed issues and identify emerging weed problems. Those data can then be used to help target management operations and to evaluate the effectiveness of weed management techniques.
- Inventories may be used to learn about the effects of management strategies across different management areas.
- Finally, inventories can help identify opportunities for future monarch-friendly revegetation efforts.

### ***How can a roadside manager assess the value of roadside vegetation for monarchs?***

There are multiple tools available for assessing monarch habitat in roadsides. These tools allow users to evaluate monarch or pollinator habitat quality, document the presence of monarch butterflies and/or pollinators, and understand outcomes of management practices. The Monarch Joint Venture's [Roadside Habitat Evaluator](#) pairs a 15-minute rapid assessment survey with a habitat calculator to provide users with information about the quality of roadside habitat for monarch butterflies. The survey runs in ESRI's Survey123 and can be customized according to information needs (paper datasheet also available).

The Rights-of-Way as Habitat Working Group's [Pollinator Habitat Scorecard](#) is a similar tool, designed for the evaluation of pollinator habitat on a range of energy and transportation lands. Organizations may choose one of three tiers, from simple to advanced monitoring, and can record data on paper or in ESRI's Survey123 (as well as on paper).

The Integrated Monarch Monitoring Program's (IMMP) [Milkweed & Blooming Plant Survey](#) evaluates monarch habitat in a variety of landscape types, including rights-of-way. The IMMP's Data Portal provides data summaries and visualization, such as the density of milkweed plants at a site, flowering plant composition, diversity, and frequency, and more. [Find a comparison of these three tools here.](#)

### ***How does roadside mowing impact monarch caterpillars and adults?***

Mowing during the growing season affects monarchs by removing nectar sources and reducing milkweed availability, and can result in direct mortality of butterfly eggs, larvae, and sometimes adults. For these reasons, mowing can set back monarch breeding temporarily and can remove nectar sources needed during monarch migration. (In some regions, mowing can stimulate milkweed regrowth, and monarchs prefer to oviposit on mown milkweed when both mowed and unmowed plants are available; see "Could roadside mowing stimulate milkweed" question below.) In general, it is preferable to mow when monarchs are not present; however, there may be circumstances when mowing when monarchs are present is more beneficial to the long-term quality of habitat for monarchs. See the Monarch Joint Venture handout "[Mowing and Management: Best Practices for Monarchs](#)" for more information, including recommended management windows. Sources: Morris 2000; Johst et al. 2006; Noordijk et al. 2009; Kayser 2014, Thomas 1984; Wynhoff 1998; Humbert et al. 2010; Kayser 2014; Phillips et al. 2020

### ***When should roadsides be mowed to reduce impacts to monarchs?***

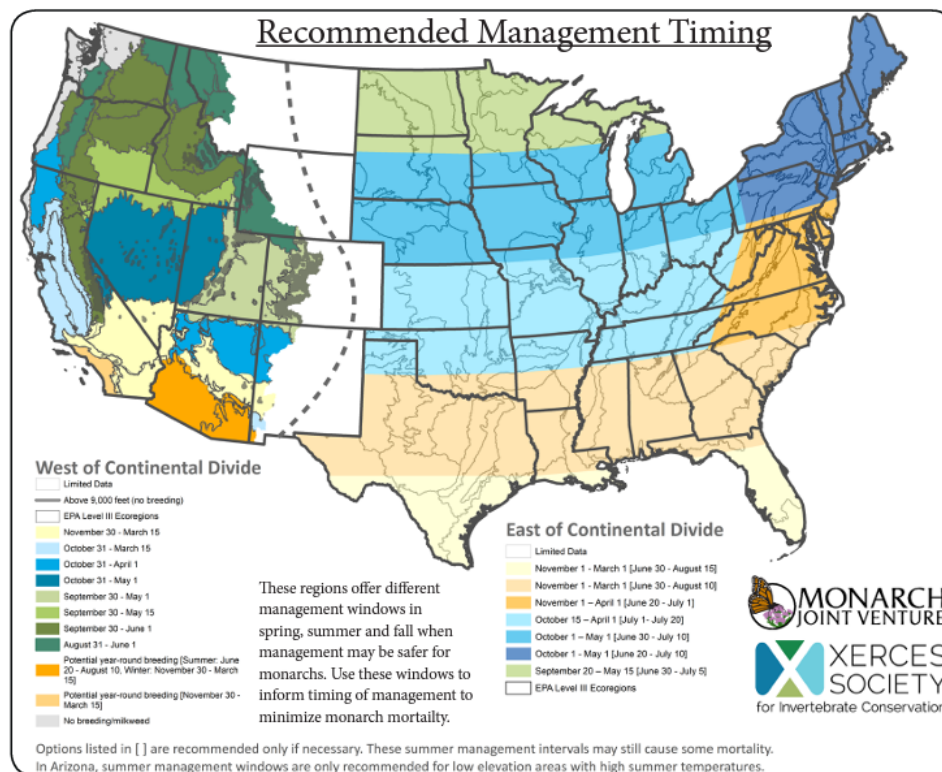
It is best to mow when monarchs are not present (see management window map below). Based on the best available data for when and where monarchs breed, [Monarch Joint Venture](#) and [Xerces Society](#) have developed regionally-appropriate monarch breeding habitat management windows. These windows are periods when management activities are least likely to have negative effects on monarchs—especially immature monarchs.

The exact timing of monarch breeding may vary from year to year and site to site (but try consulting a website such as [Journey North](#) or [Western Monarch Milkweed Mapper](#) to see when monarchs are reported in your area)—and these windows may be revised in the future as we learn more. This is especially true for

areas where few data are currently available on the timing of monarch breeding, such as the states that straddle the continental divide. Also, if milkweed is present on the landscape during the breeding season, there is a chance that monarchs are also there and that management actions could result in monarch mortality. As every year and site are slightly different, it is useful to survey milkweed plants for immature stages of monarchs prior to mowing. This is time consuming but is especially helpful if the management timing falls on the cusp of the recommended window for your region or if it has been an early spring/late fall year (see Figure 43).

### ***Could roadside mowing stimulate milkweed growth and support monarch breeding?***

Research in eastern North America has shown that spring or summer mowing can promote new growth and extend the availability of milkweed plants for monarch breeding. Mowing may stimulate growth of some milkweed species, particularly those that spread through rhizomes like common milkweed (*Asclepias syriaca*) and showy milkweed (*A. speciosa*). Summer (June or July) mowing in Michigan and southern Ontario resulted in more monarch eggs on regenerated stems than unmowed stems, and higher first instar survival. Summer (July) mowing and burning can increase green antelopehorn milkweed (*A. viridis*) availability in the late summer and early fall in the Southern Great Plains, whereas in areas without mowing, the milkweed has senesced by August. In the West, showy milkweed will regrow after summer mowing and continue to support monarch breeding (Stephanie McKnight, personal observation). However, more research is needed in other areas to determine the optimal timing and frequency of mowing that promotes not only milkweed but also nectar plants. It is also unknown if the benefit of additional milkweed availability in the fall outweighs the costs of the larval mortality caused by summer mowing. The benefits are likely greater in areas that primarily have breeding monarchs in the spring and fall and where the dominant species of milkweed spread by rhizomes. Sources: Alcock et al. 2016; Baum and Mueller, 2015; Bhowick 1994; Fischer et al. 2014; Haan and Landis 2019; Knight et al. 2019; Haan and Landis 2020



**Figure 43.** Map depicting best timing for management actions that may affect monarch breeding habitat (from [Mowing & Management: Best Practices for Monarchs](#) handout).



### ***How does roadside mowing impact nectar plant abundance and diversity?***

Frequent roadside mowing beyond the safety zone can reduce native plant species diversity and abundance and may also favor the development of grasses over herbaceous plant species, which can indirectly affect monarchs and other pollinators. However, moderate mowing levels—such as twice per season or less (it varies by region)—have been shown by multiple studies to increase plant species diversity in grassland habitats. Other studies suggest that a single mowing during the growing season or in the fall is more beneficial for floral diversity compared to two or more mowings in a year. It should be cautioned that spring or summer mowing, while potentially beneficial to plant diversity in some locations, can lead to direct mortality of monarchs and other pollinators. However, there may be circumstances when mowing when monarchs are present is more beneficial to the long-term quality of habitat for monarchs. Sources: Parr and Way, 1988; Williams et al., 2007; Mader et al., 2011; Forman, 2003; Noordijk, et al. 2009; Entsminger et al., 2017; Valtonen et al., 2007

### ***How does herbicide use on roadsides impact monarchs?***

Noxious and invasive weeds can degrade habitat for monarchs by displacing valuable nectar plants and milkweed. Herbicides are a tool employed by many transportation departments to control noxious and invasive weeds, encroaching woody vegetation, or vegetation that exceeds maximum height specifications in safety zones on roadsides. However, herbicide use can have non-target effects that reduce the quality of roadside habitat for monarchs by removing flowering plants and milkweed plants and may also have some direct negative impacts on pollinators themselves. Following best management practices for use of herbicides in relation to pollinators and other wildlife will assist managers in minimizing adverse effects on monarchs. A fact sheet on this topic summarizes recommended practices and can be found on the [Roadside Habitat for Monarchs website](#). Sources: Russell and Schultz 2014

### ***Does reduced roadside mowing increase vehicle collisions with deer or other large mammals?***

Frequency of mowing of the entire roadside does not appear to influence rates of deer–vehicle crashes. In fact, deer may prefer some roadsides that are mowed more frequently because mowing can increase the palatability of some plants. A strip of vegetation adjacent to the pavement, often referred to as the clear or safety zone, that is mowed regularly, while allowing the rest of the roadside grow to a reasonable height, can help maintain visibility for drivers and prevent deer–vehicle crashes. Driver safety may increase with the presence of wildflowers and diverse vegetation by reducing monotony on roadsides, which improves driver awareness. Sources: Mastro et al. 2008; Barnum and Alt 2013; Guyton et al. 2014

### ***Are there other advantages to reducing mowing and herbicide use beyond helping pollinators?***

Studies have demonstrated significant cost savings (up to millions of dollars per year) associated with reduced mowing and efficient herbicide use, as well as human safety benefits in terms of reduced exposure to traffic hazards, equipment, and chemical treatments. There are also many ecological benefits, including reduced carbon emissions, reduced herbicide runoff, and improved habitat for small wildlife such as grassland birds. Sources: Harrison 2014; Entsminger et al. 2019; McLaughlin et al. 2020; Storey et al. 2020; Van Dyke et al. 2021

### ***What are some roadside mowing strategies that roadside managers have used to support monarchs?***

Many departments of transportation are adopting conservation mowing programs that reduce costs while expanding pollinator habitat and reducing risks to monarchs and other wildlife. For instance, Illinois DOT has reduced mowing of roadsides beyond the 15' safety zone in many areas, mowing different sections of the right-of-way once a growing season rather than mowing the entire right-of-way.

Texas DOT also manages rights-of-way for the protection of wildflowers and pollinators. Mowing operations

start after the spring flowers have bloomed and set seed, usually around June. This is the best time for the mowing operation and by this time the monarchs are out of the state. Mowing at this time opens the canopy for warm season species, and TxDOT sets all mowers to 7 inches to ensure less damage to warm season plants. TxDOT also conducts a fall mowing operation that opens up the canopy so the cool season flowers have room to germinate and establish for the following year. TxDOT also sets aside as much right of way as possible in non-mowed areas. These areas are great for wildlife habitat and fall blooming nectar plants such as Maximillian sunflower, goldenrod and gayfeather.

Case studies are available at the Federal Highway Administration's Pollinators page in their [Environmental Review Toolkit](#) (Select the State DOT Pollinator-Friendly Practices and Information tab).

### ***How do non-native and/or invasive plants in roadsides affect milkweeds and monarchs?***

Invasive plants on roadsides can greatly reduce the abundance of milkweeds by outcompeting them for water, light, space, and nutrients, and thereby limit the reproductive potential of monarchs. Invasive plants can also outcompete the wildflowers that serve as nectar sources for monarch adults. By reducing the abundance and diversity of milkweeds and nectar sources, invasive plants reduce the food supply for adult monarchs and other pollinators, leading to reduced abundance. A 2008 study demonstrated that roadsides with native vegetation support a greater abundance and richness of pollinators than those with invasive and non-native species. *Sources: Hopwood 2008*

### ***How can the transfer of seeds on mowing equipment affect roadside habitat for monarchs?***

Mower decks (above and underneath), the area around the gear box, as well as blades and shafts can transfer the seeds of noxious and invasive weeds, species that can seriously degrade vegetation quality and diversity once they invade new sites. Adult monarchs rely on diverse sources of nectar throughout the breeding season as well as during migration. If invasive species become dominant, this can reduce the diversity of native plants available to provide nectar throughout the entire growing season. Preventing the spread of weed seed can help to reduce new invasions.

### ***How does haying of roadsides affect monarchs and milkweeds?***

Annual haying at the right time can benefit herbaceous roadside plant communities by suppressing the growth/encroachment of woody vegetation and reduce competition from tall grasses, allowing flowering plants to thrive. However, it can have negative effects on monarchs by abruptly removing milkweed and flowers at a site and destroying immobile eggs and larvae. To provide refuges for monarchs, harvest hay in strips or patches, instead of harvesting hay from an entire site. Cut hay at a high height (8–12"), so that some wildflowers can recover and go on to flower later in the season. Varying the season of haying from year to year may increase overall plant diversity. *Sources: Feber et al. 1996, Foster et al. 2009*

### ***What impact does fire (either prescribed burns or wildfire) have on roadside monarchs and milkweeds?***

Prescribed fire is an important management tool; if carefully implemented, fire can be used to control unwanted woody vegetation and some invasive plants, stimulate wildflowers in fire-adapted plant communities, and reduce plant litter buildup that can suppress nectar resources for pollinators such as the monarch. The response of adult monarchs has been reported to be positively correlated with the post-fire availability of nectar resources, with significantly more monarchs using burned areas compared to unburned areas, especially during the first growing season after a fire. Burns (either prescribed or wild) during the growing season may stimulate growth of certain milkweeds, depending on the region (e.g., in Oklahoma, researchers found that summer prescribed fire stimulated resprouting of *Asclepias viridis*). However, implementing fire during the monarch breeding season can directly kill monarch eggs, larvae, and pupae,

and temporarily remove nectar and host plant resources for adult monarch butterflies. Adjusting the timing of prescribed fire to occur outside the monarch breeding and migration season can reduce the impacts to monarchs. Implementing fire in the early spring before monarchs arrive to a region, in late fall after monarch migration is complete, or in the winter will have the least direct impacts on the butterfly. However, in some regions and under some circumstances, the long-term benefits to vegetation management or plant diversity of using prescribed fire while monarchs are present may outweigh the short-term costs. *Sources: Rudolph and Ely, 2006; Vogel et al., 2007; Baum and Sharber, 2012; Moranz et al., 2012.*

## Revegetation

### ***What kinds of plants can be planted on roadsides to support monarchs?***

In each region, there are many native species that can be planted on roadsides to support monarchs. We have produced regional [recognition guides](#) that highlight the most common milkweed species along roadsides. The Xerces Society has also produced [lists of monarch nectar plants](#) for each region of the lower 48 states. The USDA's Natural Resources Conservation Service (NRCS) has produced [monarch nectar plant guides](#) for 5 regions of the country (and many of the state NRCS offices have developed lists for their state).

### ***What plants do monarchs use as nectar sources?***

Documented nectar plants for monarchs are summarized in regional lists (below), but additional studies will increase our knowledge of the plants they use. Although they are known to nectar on a wide variety of plants (and thus are considered nectar plant generalists), there are many plant species that they rarely or never visit, and a smaller number of plant species that they strongly prefer. For example, many milkweed species, in addition to providing food for caterpillars, are also preferred nectar sources. Until we know more about monarch nectar preferences, you can refer to the regional monarch nectar plant lists that the Xerces Society in collaboration with Monarch Joint Venture or the NRCS have developed for each region of the lower 48 states.

These plant lists are available at:

- [xerces.org/monarch-nectar-plants](http://xerces.org/monarch-nectar-plants)
- [nrcs.usda.gov/wps/portal/nrcs/detail/national/plantsanimals/pollinate/?cid=nrcseprd402207](http://nrcs.usda.gov/wps/portal/nrcs/detail/national/plantsanimals/pollinate/?cid=nrcseprd402207)
- [calflora.org/app/ipl?list\\_id=px771&incvar=t](http://calflora.org/app/ipl?list_id=px771&incvar=t)

### ***When revegetating roadsides, how can planners consider the needs of monarchs?***

Include wildflowers or shrubs that are nectar sources for adult monarchs. Include a diversity of species that bloom in each season (spring, summer, and fall) so that nectar is available throughout the entire monarch breeding and migration periods. See “What plants do monarchs use as nectar sources?” above for nectar plant lists.

Include native milkweed species in seed mixes or in landscape plantings for monarch caterpillars. In regions where milkweed is difficult to establish from seed (e.g., California), using transplants may be a more cost-effective way to establish milkweed in roadside habitat. For a directory of sources of milkweed seed, visit [xerces.org/milkweed-seed-finder](http://xerces.org/milkweed-seed-finder).

### ***What are some general guidelines for designing seed mixes or landscape plans for roadsides that can support monarchs?***

- Include a diversity of plants; diverse communities are better able to prevent erosion, resist weeds, help with water infiltration, and are aesthetically pleasing.
- Include species that can fill different roles. Cool season grasses green up early in the spring and can provide erosion control from late winter into early summer, while warm-season grasses provide erosion control as they grow through the warm summer months and into the fall. Legumes can fix nitrogen and improve soil health. Annual forbs will establish quickly to provide attractive vegetative cover, erosion control, and nectar for monarchs during the time it takes for longer lived perennial forbs to establish.
- Avoid taller herbaceous plants in areas where lines of sight could be blocked, such as intersections and other safety zones.
- In areas with snow and ice, species to be planted close to the road should have some level of salt tolerance to reduce damage from road salt applications.
- Include species adapted for the soil conditions present at the roadside site (e.g., use moisture-tolerating species for wet ditches), or, if seed mixes cannot be context-specific, include species adapted to a wide range of growing conditions.
- Focus on wildflowers that establish easily and are relatively inexpensive, but also include some species that are harder to establish and may be a bit more expensive to increase the aesthetics of the planting and the value of the habitat to monarchs.
- To achieve high plant diversity and long-term stability of a stand of vegetation intended for erosion control, a minimum of 25% of the seed mix should be wildflowers, but 50% results in a considerably more diverse planting. In highly visible areas, seed mixes for showy plantings should include greater than 50% wildflower component.
- Check erosion control mulches, seed laboratory reports, and legal seed labels of the planting stock. Mulches, seed, and other planting stock should be free of noxious weeds, invasive/introduced species and other crop components.
- Where available and economical, native plants and seed should be procured from local ecotype providers. Local ecotype plant materials are adapted to the local climatic conditions and will generally establish well and will have bloom times in sync with the presence of monarchs and other pollinators. Some cultivars have been bred for a particular trait such as showiness and may have little to no pollen and nectar and therefore little value to monarchs. *Sources: Lippitt et al., 1994; Hopwood et al., 2015*

### ***Why use native plants in new roadside plantings if they are more expensive than nonnative species?***

In addition to their value to pollinators, there are many advantages of using native plants to stabilize roadsides. Native grasses and flowers are best adapted to local growing conditions, require minimal inputs for establishment, and can tolerate extreme weather events such as drought. Native plants in roadsides are less likely than many nonnative plants to become weed issues and encroach on adjacent land. The root systems of native plants can increase water infiltration, which reduces runoff and water pollution and keeps our waters cleaner. A diverse native plant community can reduce soil erosion and resist weed invasions, which can reduce maintenance costs. Although native plants may cost more upfront, they can provide cost savings over time. Native plants can be aesthetically pleasing during the growing season while also acting as snow fences in the winter, trapping and preventing snow from blowing across roads. Roadsides with a diverse assemblage of plants sequester more carbon than weedy or species poor habitats. Native plant communities also support more birds, pollinators, and other wildlife. The use of native plants in roadsides can provide ecological benefits to the surrounding landscape. *Sources: Cramer 1991; Bugg et al. 1997; Harper-Lore and Wilson 2000; Johnson 2000; Ries et al. 2001; Quales 2003; Blumenthal et al. 2005; Tilman et al. 2006; Tallamy and Shropshire 2009; Williams et al. 2011; Harrison 2014; Harper-Lore et al. 2014.*

### ***What should planners consider when selecting sites for roadside plantings that support monarchs?***

When thinking about where to prioritize plantings that support monarchs, planners should consider the

surrounding landscape, existing weed pressure, width of site, visibility to the public and potential for community engagement. Considerations include:

- Prioritize sites that are unlikely to undergo construction within 10-15 years following establishment of vegetation to ensure the long-term persistence of the plantings and to protect the investments of cost and time.
- Focus efforts on the widest roadsides to maximize potential habitat.
- Prioritize sites that are along roads with lower traffic volume and speed, and those that connect other existing habitat within the landscape.
- Sites with high weed pressure may be challenging to return to native vegetation; DOTs that have limited experience with native plant revegetation may want to begin revegetation efforts on sites with low weed pressure.
- If a project goal is to highlight the value of DOT rights-of-way, sites planted with showy wildflowers to benefit monarchs and pollinators should be located in areas that are visible to the public, such as rest areas, or sites near farms that could benefit from the pollination services the roadside habitat would help to support (e.g., roadside sites near almond orchards in California). Public education and perception of the planting is important. Visible plantings may make surrounding landowners more aware of the importance of roadside habitat, which may decrease landowner spraying, mowing, or haying of the roadside. Signage can also be a valuable tool for educating community members – [download, print, or buy existing signs here](#).

#### ***What kinds of tools are available to guide or inform decisions of planners?***

- **Landscape Prioritization Model**: A habitat prioritization modelling tool is available through the [Roadside Habitat for Monarchs](#) website. The GIS model helps roadside rights-of-way managers assess how the roads in their state relate to landscape-scale factors affecting monarch habitat quality. The model identifies areas of low- and high-quality monarch habitat and can be used to locate areas where roadside habitat may complement high functioning surrounding habitats, identify places where the landscape is providing little surrounding monarch habitat, and to select sample locations for surveys of monarch habitat within roadside rights-of-ways.
- **Ecoregional Revegetation Assistant Tool**: A map-based tool to aid practitioners when selecting native plants for restoration and pollinator habitat enhancement. The map can be searched by US Environmental Protection Agency (EPA) Level III Ecoregions, as well as by state. The database includes plant attributes such as soil type, moisture needs, palatability, salt tolerance, and value to pollinators, including nectar plants for monarchs. The plant species found within an ecoregion can be filtered by attributes, and a list of workhorse plant species can also be generated. This is part of a collaboration between the [Federal Highway Administration](#), [US Forest Service](#), [WSP](#), and [Xerces Society](#). This tool can help practitioners to select native plants suitable for revegetation of a site by using filters for needed plant attributes, including value to pollinators. The tool is available at [nativerevegetation.org/era](#).
- **Roadside Revegetation - An Integrated Approach to Establishing Native Plants and Pollinator Habitat**: This report offers an integrated approach to facilitate the successful establishment of native plants and pollinator habitats along roadsides and other areas of disturbance associated with road modifications. The report takes practitioners through a comprehensive process of initiation, planning, implementation, monitoring and operations & maintenance of a roadside revegetation project with native plants for creating pollinator habitats, and describes adapting/improving processes for future projects. The comprehensive 500+ page online report offers an integrated approach to facilitate the successful establishment of native plants and pollinator habitat along roadsides and other areas of disturbance associated with road modifications. A primer and resource library accompanies the report. Available at: [nativerevegetation.org/learn](#).

# Monarch Candidate Conservation Agreement with Assurances (CCAA)

## ***What is the Monarch CCAA?***

The monarch is a candidate species under the Endangered Species Act, which means it is at risk and likely to become listed if no action is taken to prevent it. Many managers from the energy and transportation sector are acting proactively to protect monarchs by entering into a nationwide Candidate Conservation Agreement with Assurances (CCAA), developed by the Rights-of-Way as Habitat Working Group at the University of Illinois Chicago. This agreement with the USFWS encourages transportation and energy organizations to take steps to create monarch habitat now, so that even if the monarch becomes a threatened or endangered species, quality habitat will already be in place to help the monarch recover. This also ensures that land managers will not have to take additional conservation measures if the butterfly becomes listed in the future.

## ***How can energy and transportation organizations enroll in the Monarch CCAA?***

By enrolling in the Monarch CCAA, energy companies and transportation organizations voluntarily commit to implement conservation measures on a portion of their managed lands. The CCAA remains open for enrollment until a future effective listing date. Applications must be submitted to the University of Illinois Chicago, which administers the Monarch CCAA, prior to the effective listing date to be eligible to enroll. [Learn more here](#).

## ***How can I track and report my conservation efforts?***

The [Rights-of-Way as Habitat Geospatial Database](#) provides a platform for energy and transportation organizations to track and report their habitat restoration and conservation measures. The database quantifies pollinator habitat managed on energy and transportation rights-of-way and other lands to inform habitat restoration activities, communicate the conservation value of these spaces, and facilitate collaborative projects between participating organizations.

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Jennifer Hopwood, Emma Pelton, Ray Moranz, Stephanie McKnight, Stephanie Frischie (Xerces Society for Invertebrate Conservation), Laura Lukens (Monarch Joint Venture)

## **Acknowledgements**

We thank the following reviewers for their input on this document: Wendy Caldwell (Monarch Joint Venture), Alison Cariveau (Monarch Joint Venture), Angela Laws (Xerces), Dennis Markwardt (Texas DOT), Dennis Martin (Oklahoma State University), Cora Lund Preston (Monarch Joint Venture), Iris Caldwell (UIC Energy Resources Center).

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