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2019 TECHNICAL REPORT

Conservation Actions for Electric Power Companies to Support Monarch Butterflies

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ABSTRACT

The Electric Power Research Institute (EPRI) worked with the Xerces Society for Invertebrate Conservation to develop this report, which synthesizes the scientific literature and existing best management practices for monarch butterflies along with input from a survey of monarch experts and a survey of EPRI members. Monarch experts were surveyed to identify the relative benefit of specific conservation actions for monarchs as well as to provide opinions on the opportunities for power companies to engage in monarch conservation. The Company Survey attempted to capture details from power companies regarding land management responsibilities, potential and current implementation of monarch conservation actions, and to identify barriers to adopting monarch-friendly management.

The report describes the conservation actions for monarch habitat protection, management, enhancement, and restoration that are compatible with the land use and management of electric power company properties. Specific land management practices covered include herbicide use, controlling invasive species, brush and tree management, mowing, prescribed fire, grazing, and restoration and revegetation. This report shows that it is important to consider the specific land asset type in relation to supporting monarchs, including transmission lines, distribution lines, power plant sites, surplus properties, solar sites, wind sites, and substations. Conservation actions are mapped to the various land asset types to understand where the greatest monarch conservation potential exists. We also explore opportunities for power companies in monarch conservation education, training, and outreach.

Keywords
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PRIMARY AUDIENCE: Electric power companies managing for monarch butterfly conservation

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KEY RESEARCH QUESTION

Threats to pollinators may have profound consequences for ecosystem health as well as our food systems. Concerns about pollinator declines and associated repercussions have led to increased efforts by non-governmental organizations and both public and private sectors to reduce threats to pollinators. One of the most iconic pollinator species, the monarch butterfly (Danaus plexippus plexippus), is threatened by habitat loss, insecticides and herbicides, and climate change—and is now being considered for listing under the U.S. Endangered Species Act. Where are the best opportunities to support monarchs, given the barriers and constraints power companies face?

RESEARCH OVERVIEW

The Electric Power Research Institute (EPRI) worked with the Xerces Society for Invertebrate Conservation (Xerces) to develop this report, which synthesizes the scientific literature and existing best management practices for monarch butterflies along with input from a survey of monarch experts and a survey of EPRI members. Monarch experts were surveyed to identify the relative benefit of specific conservation actions for monarchs as well as to provide opinions on the opportunities for power companies to engage in monarch conservation. The Company Survey attempted to capture details from EPRI members regarding land management responsibilities, potential and current implementation of monarch conservation actions, and to identify opportunities and barriers to adopting monarch-friendly management.

KEY FINDINGS

- Because it is important to conserve monarch habitat in all the regions where it occurs, nearly every electric power company in the United States has an opportunity to support monarchs.
- Electric power companies are interested in understanding meaningful opportunities to support the monarch butterfly and other pollinators.
- Most electric power companies embed monarchs within their larger pollinator conservation efforts—if they have those efforts in place—rather than having a monarch-specific conservation program.
- Primarily, it is important for power companies to identify, protect, and manage existing monarch habitat through appropriate timing and application of land management techniques. Secondarily, efforts can be made to enhance or restore habitat where appropriate.
- This research reveals that considering conservation actions independent of the property type and on-field site conditions is unlikely to highlight legitimate and specific conservation opportunities for electric power companies. Rather, we found it necessary to look at each facility and property type to understand the applicable conservation actions and barriers.

WHY THIS MATTERS

The monarch is a culturally iconic and ecologically important species. Because it is important to conserve monarch habitat in all the regions in which it occurs, nearly every electric power company in the United States has an opportunity to support monarchs. This report helps answer a critical question: "Where are the best opportunities to support monarchs, given the barriers and constraints power companies face?"

HOW TO APPLY RESULTS

The report describes the conservation actions for monarch habitat protection, management, enhancement, and restoration that are compatible with the land use and management of electric power company properties. Specific land management practices covered include herbicide use, controlling invasive species, brush and tree management, mowing, prescribed fire, grazing, and restoration and revegetation.

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PROGRAM: Power-in-Pollinators Initiative and Endangered and Protected Species, P195

REPORT SUMMARY

The Electric Power Research Institute (EPRI) worked with the Xerces Society for Invertebrate Conservation (Xerces) to develop this report, which synthesizes the scientific literature and existing best management practices (BMPs) for monarch butterflies along with input from a survey of monarch experts and a survey of EPRI members. Monarch experts were surveyed to identify the relative benefit of specific conservation actions for monarchs as well as to provide opinions on the opportunities for power companies to engage in monarch conservation. The Company Survey attempted to capture details from EPRI members regarding land management responsibilities, potential and current implementation of monarch conservation actions, and to identify barriers to adopting monarch-friendly management.

Electric power companies are interested in understanding meaningful opportunities to support the monarch butterfly and other pollinators.

The primary threats to monarchs include habitat loss, insecticides and herbicides (primarily on agricultural lands), and climate change. Monarch breeding and migratory habitat is found broadly over the vast majority of the lower 48 states and into southern Canada; monarch overwintering habitat in the United States is found primarily along the coast of California. Because it is important to conserve monarch habitat in all the regions where it occurs, nearly every electric power company in the United States has an opportunity to support monarchs.

The question for monarch conservation by power companies is, "Where are the best opportunities to support monarchs, given the barriers and constraints power companies face?"

Although the monarch is the species of focus of this report, numerous other pollinator species are also in decline and/or already listed under the U.S. Endangered Species Act (ESA). It is important to consider opportunities to support a suite of pollinators, both to reduce corporate risk of future listings and for the value of the species in human cultural and spiritual well-being and ecosystem health. It is also important to consider threats to other important species (for example, grassland birds and other at-risk pollinators) when developing a monarch habitat management plan to ensure that other species are not inadvertently being harmed while managing for monarchs specifically.

This research attempts to highlight the best conservation opportunities for monarchs that electric power companies can implement. It is difficult to rank the value of various conservation actions for monarchs and is even more complex to map conservation actions to specific property types based on current land management practices and future conservation opportunities. Power companies may need to adapt these recommendations for their own situations to consider site-specific, regional, or other factors when making management decisions.

The report describes the conservation actions for monarch habitat protection, management, enhancement, and restoration that are compatible with the land use and management of electric power company properties. Specific land management practices covered include herbicide use, controlling invasive species, brush and tree management, mowing, prescribed fire, grazing, and restoration and revegetation. We also recognize that, in some circumstances, there may be conservation trade-offs (short-term impacts vs. long-term benefits) of specific practices to monarchs and their habitat (such as prescribed burning or herbicide use). In these cases, we recommend leaving areas of refugia and using methods to minimize short-term negative impacts to the species while still considering the long-term habitat benefits.

Conservation actions that have the greatest monarch conservation potential (based on expert input) and that are the most feasible to implement (based on EPRI-member input) are highlighted as high-priority actions. We also explore opportunities for power companies in monarch conservation education, training, and outreach.

A key finding is that most electric power companies embed monarchs within their larger pollinator conservation efforts—if they have those efforts in place—rather than having a monarch-specific conservation program.

Primarily, it is important for power companies to identify, protect, and manage *existing* monarch habitat through appropriate timing and application of land management techniques. Secondarily, efforts can be made to enhance or restore habitat where appropriate.

This research reveals that considering conservation actions independent of the property type and on-field site conditions is unlikely to highlight legitimate and specific conservation opportunities for electric power companies. Rather, we found it necessary to look at each facility and property type to understand the applicable conservation actions and barriers.

The greatest facility and property-specific opportunities include the following:

- **Transmission line rights-of-way (ROW)**: Consider an integrated vegetation management (IVM) plan to specifically protect pollinators with consideration of monarchs. Identify, protect, and manage **existing** monarch habitat. Promote native low-growing plant communities, limit broadcast herbicide application, revegetate disturbed areas with a pollinator-friendly seed mix including locally native milkweed and nectar plants, manage invasive vegetation with targeted herbicide and/or mechanical means, and, when possible, mow/control woody vegetation that is intermixed with monarch habitat when monarchs are not breeding in your region.

- **Power plant properties**: To the extent possible while allowing for site access and clearance requirements, adopt a site management plan that incorporates relevant conservation actions noted in this report. Identify, protect, and manage **existing** monarch habitat. Plant pollinator-friendly seed mixes including locally native milkweed and nectar plants. Limit broadcast herbicide use and shift mowing frequency and/or timing to protect monarch breeding and nectar feeding.

- **Substations**: To the extent possible while allowing for site access and equipment clearance requirements, plant pollinator-friendly seed mixes including locally native milkweed. Identify, protect, and manage **existing** monarch habitat. Limit broadcast herbicide use and reduce mowing frequency and/or timing. Given the smaller footprint of substations as individual properties, consider prioritizing substations for planting based on adjacency to other protected areas that may provide pollinator habitat, when possible.

- **Surplus property**: Surplus properties vary widely in size. Ideally, start with properties that are large enough in size to allow for pollinator revegetation/restoration projects to coexist along with other current or foreseen future uses for the property. Identify, protect, and manage EXISTING monarch habitat. Adopt a site management plan that incorporates the conservation actions noted in this report. Plant pollinator-friendly seed mixes including locally native milkweed and nectar plants. Limit broadcast herbicide use and reduce mowing frequency and/or timing to avoid monarch breeding activity.
- **Solar and wind sites**: With increasing amounts of wind and solar sites in North America, it is useful to consider the value of these properties for monarchs and other pollinators. However, because a large portion of these sites is owned by emerging power providers and not the traditional electric power companies, a relevant action may be to include pollinator-friendly requests or requirements in power purchase agreements.

There are several important limitations to this report, most notably the following:

- This report **does not** consider the likelihood of monarchs receiving protection under federal or state law nor economic, business, or ecological consequences of these potential protections from such a listing decision.
- This report **does not** attempt to consider financial costs of the various conservation actions. However, electric power companies are generally and widely concerned about the costs and effort for implementing new conservation actions.

This is a comprehensive report that includes the entirety of the research results. We apologize for the repetition of some points for those who read the report in its entirety. For readers interested in specific topics, we recommend using key search terms (for example, *substations*, *mowing*) to skip to the most relevant information.

LIST OF ABBREVIATIONS

AUM	animal unit months
BMP	best management practice
BONAP	biota of North America
DNR	Department of Natural Resources
EDRR	early detection rapid response
ESA	Endangered Species Act
FWS	Fish and Wildlife Service
HDSD	high-density short duration
IVM	integrated vegetation management
MPH	miles per hour
NRCS	Natural Resources Conservation Service
OE	*Ophryocystis elektroscirrha*
OHV	off-highway vehicle
PLS	pure live seed
PPAs	power purchase agreements
RCRA	Resource Conservation and Recovery Act
ROW	rights-of-way
WHEG	Wildlife Habitation Evaluation Guide

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1
INTRODUCTION

Threats to pollinators may have profound consequences for ecosystem health as well as our food systems (Kearns et al., 1998; Spira, 2001; Steffan-Dewenter and Westphal, 2008). Concerns about pollinator declines and associated repercussions have led to increased efforts by non-governmental organizations and both public and private sectors to reduce threats to pollinators. One of the most iconic pollinator species, the monarch butterfly (*Danaus plexippus plexippus*), is recognized and celebrated by people throughout North America; the butterfly's annual migration stretches from southern Canada to Mexico, covering most of the lower 48 United States during the spring and summer. But monarchs are in trouble. The overwintering population in central Mexico has declined by ~80% since the 1990s (Semmens et al., 2016). The overwintering population in coastal California has declined by 97% since the 1980s (Schultz et al. 2017) and, in winter of 2018–2019, the population crashed to a mere 0.6% of its historic size (Xerces Society Western Monarch Thanksgiving Count, 2019). Threatened by habitat loss, insecticides and herbicides, climate change, and other stressors, the species is now being considered for listing under the U.S. Endangered Species Act. Contributions to species conservation efforts can therefore be investments toward helping a species rebound and averting a listing.

Electric power companies have an opportunity to play a part in the monarch's recovery. They own and/or manage a substantial amount of land and associated natural resources across North America, including transmission and distribution rights-of-way (ROW), solar fields, wind fields, buffer areas surrounding power plants and substations, and "surplus" land holdings. These acres hold the potential to create a network of habitat to support monarchs and other pollinators across their breeding range. Together, power companies have an opportunity to make a difference by considering the needs of these important animals when managing habitat and revegetating land.

How to Use This Report

This is a comprehensive report that includes the entirety of the research results. Although the report can be read in its entirety, we envision that many readers will be interested in quickly accessing information relevant to their situation. For this reason, there is some repetition of important points that may otherwise be overlooked by a reader focused solely on particular topics. We apologize for the repetition of some points for those who read the report in its entirety.

We recommend that all readers review Section 1: Introduction and Section 2: Purpose, Approach, Limitations. For readers interested in specific topics, we recommend using key search terms (for example, *substations*, *mowing*) to skip to the most relevant information. For readers interested in a specific land management practice, we recommend using the Table of Contents to jump to land management practices separated out by section (for example, herbicide use).

2
PURPOSE, APPROACH, LIMITATIONS

Purpose

To better understand how electric power companies are already helping monarchs and identify ways in which they can further aid the species, the Electric Power Research Institute (EPRI) partnered with the Xerces Society for Invertebrate Conservation (Xerces) beginning in 2018. The project asked three main questions:

1. What is the role of power companies in monarch impacts and conservation?
2. What are the most meaningful specific monarch conservation actions that a power company can take?
3. What are the barriers and possible solutions for the implementation of monarch conservation actions by power companies?

In addition to attempting to identify the best opportunities for conservation for a broader set of electric power companies, this report will be a long-standing resource for individual companies wanting a comprehensive list of possible conservation actions to consider.

The conservation actions discussed in this report are focused on monarch protection. They are based on the biology of monarch butterflies and may conflict with other priorities of power companies and, in some cases, other species. For example, applications of certain herbicides may be most effective if applied outside of the recommended management window, or mowing times that are best for monarchs may be less desirable for other at-risk species. Power companies should consider their own situations and associated factors and adapt these recommendations accordingly.

Figure 2-1 illustrates EPRI monarch research priorities.

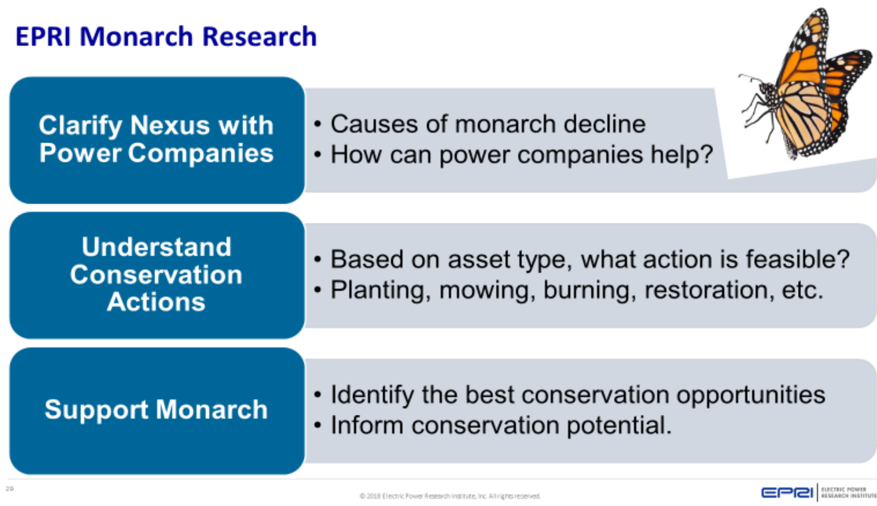


Figure 2-1
Overview of EPRI monarch research

Approach

To answer these questions, Xerces and EPRI developed an approach that included a literature review, a survey for monarch scientific experts (Expert Survey), and a power company survey (Company Survey).

Literature Review

Xerces reviewed hundreds of published scientific papers on monarchs and pollinator habitat management as well as relevant grey literature and existing best management practices (BMPs) for monarchs, including the *Mid-America Monarch Conservation Strategy* (MAFWA, 2018), *Western Monarch Butterfly Conservation Plan* (WAFWA, 2019), and Xerces' *Managing for Monarchs in the West: Best Management Practices for Conserving the Monarch Butterfly and its Habitat* (Xerces, 2018). The literature review led to the identification of a wide range of possible conservation actions for monarchs. These conservation actions were then posed to monarch experts and EPRI members in separate surveys (Expert Survey and Company Survey) and refined to the most relevant and meaningful set of conservation actions for the electric power industry, as presented in this report. Conservation actions include improving existing management activities to make them more "monarch-friendly" as well as adopting new actions to benefit monarchs (for example, monitoring for milkweed and creating or enhancing monarch habitat).

Expert Survey

Xerces conducted a detailed online survey with leading monarch experts from across the United States to ensure that the most current science is being considered in this report (Expert Survey, Appendix A). The survey asked experts to identify the relative benefit of specific conservation actions for monarchs as well as provide opinions on the opportunities for power companies to implement practices. A list of the 17 questions experts were asked can be found in Appendix A. A total of 12 experts were contacted to participate in the survey, and 9 completed the survey, yielding a 75% response rate. Participants included academic monarch experts (5), a federal agency (1), a state agency (1), and non-governmental organizations (2). Self-described geographic areas of expertise included California, Eastern United States, Western United States, Midwest, Southern Great Plains, Intermountain West, Pacific Northwest, Southwest, and National. (Note that some experts self-identified as having more than one geographic area of expertise.) Expert opinion informed the recommended conservation actions and discussions of priority actions for electric power companies. Expert input on specific topics is highlighted using a ↠ symbol.

Company Survey

EPRI conducted a comprehensive online survey that it distributed to EPRI members who were the 2018 funders of the EPRI Power-in-Pollinators Initiative and the EPRI Protected Species Research Program 195 (see Table 2-1). The survey attempted to capture details regarding land management responsibilities, potential and current implementation of monarch conservation actions, and barriers to adopting specific monarch-friendly management (Company Survey, Appendix B). The survey included 70 detailed questions and asked companies to report the extent to which they were implementing various conservation actions by land asset type (that is, transmission lines, solar sites, or power plants). EPRI and Xerces together developed the overall survey design. The list of conservation actions included in the survey was developed by Xerces and informed by the literature review and Expert Survey. We attempted to collect both overall data on the vegetative assets themselves as well as barriers and constraints for supporting monarchs on those specific asset types (power plant sites, substations, and transmission lines, among others). A total of 24 companies[1] were invited to participate, with 18 completing the survey, yielding a 75% response rate.

Table 2-1
EPRI-member companies invited to take Company Survey

Alliant Energy
Ameren
American Electric Power
Arkansas Electric Cooperative Corporation
Bonneville Power Administration
Consolidated Edison
Consumers Energy
Dairyland Power Cooperative
DTE Energy
Duke
Exelon
FirstEnergy

[1] The number of companies was tracked based on parent companies, not separate subsidiary companies.

Table 2-1 (continued)
EPRI-member companies invited to take Company Survey

Great River Energy
HECO
Lincoln Electric System
Nebraska Public Power District
New York Power Authority
NiSource
Portland General Electric
Salt River Project
Southern Company
Sunflower Electric Power
Tennessee Valley Authority (TVA)
Anonymous Company

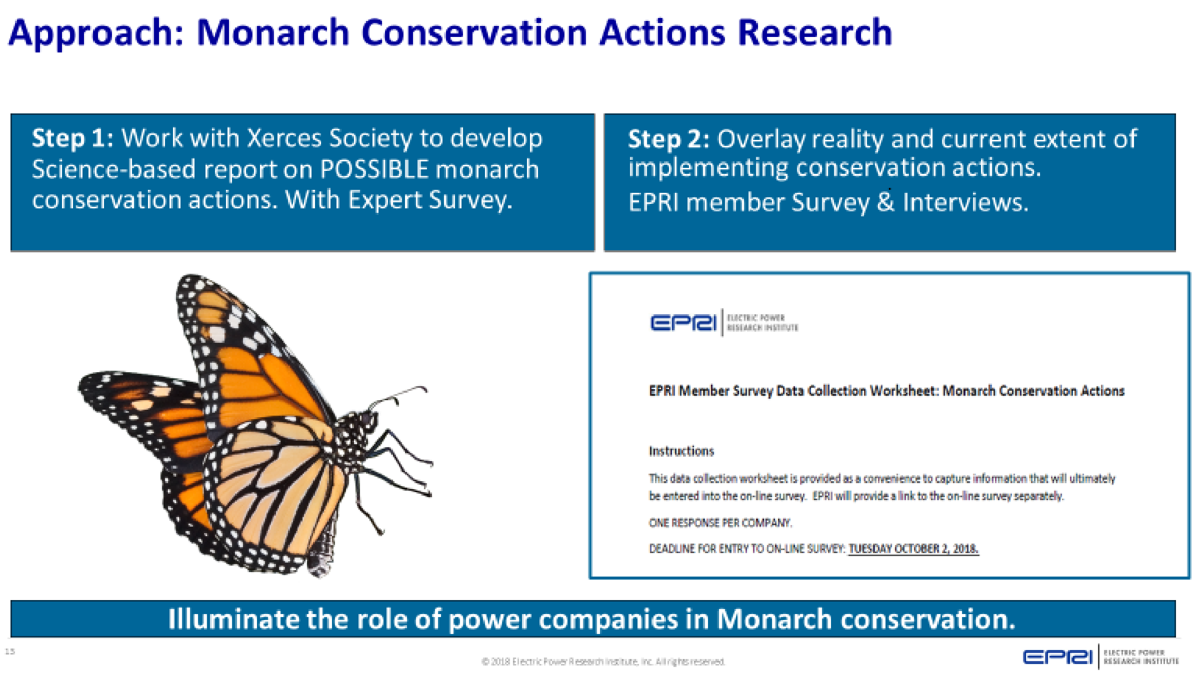


Figure 2-2
Monarch conservation actions research

Research Team

EPRI is a nonprofit organization that conducts public interest energy and environmental research, development, and demonstration projects for the benefit of the public in the United States and internationally. More than 50 years old, EPRI focuses research on electricity generation, delivery, and use in collaboration with the electricity sector, its stakeholders, and others. In terms of reach, EPRI members produce and deliver approximately 90% of electricity in the United States alone.

The Xerces Society for Invertebrate Conservation is an international nonprofit organization that protects wildlife through the conservation of invertebrates and their habitats. Xerces is a science-based conservation organization, working with diverse partners including scientists, land managers, educators, policymakers, farmers, and citizens. Xerces uses applied research, engages in advocacy, provides educational resources, and addresses policy implications to make meaningful long-term conservation a reality. Xerces staff have regional expertise working on projects across the United States—including Hawaii and Alaska—and have staff in 14 states in all regions of the country working on pollinator conservation.

Limitations and Disclosures

There are several important limitations and disclosures related to this research. All results and conclusions should take these limitations and disclosures under consideration:

- This report **does not** consider the likelihood of the monarch receiving protection status under federal or state law nor economic, business, or ecological consequences of such a listing decision.
- This report **does not** attempt to consider financial costs of the various conservation actions; however, electric power companies are generally and widely concerned about the costs and effort of implementing new conservation actions.
- In this report, the use of *electric power industry* recognizes the diversity of the companies that make up the industry. There are investor-owned utilities, public power administrations, local cooperatives, multi-state and national companies, and vertically integrated generation-only and distribution-only companies, among others. General statements about electric power companies are made with caution.
- There is likely bias in the companies that took the Company Survey. The survey was offered only to funders of EPRI's Power-in-Pollinators Initiative and EPRI's Endangered and Protected Species research program (Program 195). All of these companies have shown a general interest in research related to pollinators and/or protected species. Therefore, Company Survey results may be biased toward organizations already engaged in related research and **cannot** be extrapolated to non-participating companies, EPRI members as a whole, or the larger electric power industry.
- The Company Survey was detailed and required collection of significant amounts of company information, which could have impacted the ability to provide detailed answers for all participating companies. With 70 unique questions that required data collection from many different corporate departments (generation, transmission, real estate, renewables, vegetation management, and corporate), the survey request was large. EPRI estimated 40

hours of staff time per company to collect the information in the survey. Direct communication between the companies and EPRI (Jessica Fox, Sr. Technical Executive) revealed that companies made their very best effort in collecting accurate responses, but there may be some errors due to availability of knowledgeable company staff during the survey response period. Note, for example, the following direction to respondents: "Full data accuracy would likely require detailed GIS analysis to separate out vegetative vs. non-vegetative areas. We are NOT asking you to do this. When data is limited, we would like you to use best professional judgement in answering the questions with your best attempt to estimate vegetative areas."

- Many Company Survey questions were detailed and specific. Results of any particular survey questions should not be taken as individually suggestive of the larger status of monarch habitat management by either the companies participating in this research or the larger electric power industry.
- The monarch experts solicited to participate in the Expert Survey were selected by Xerces and EPRI staff because they have a diversity of geographic and conservation expertise. However, participating experts may not be representative of all monarch experts or all geographies. Agreement as well as important differences in expert opinion of best practices were highlighted where possible in the report and generally addressed through emphasizing multi-pronged conservation actions. Not all Expert Survey results are presented in this report. Experts were also solicited to provide review of a draft version of the report along with comments about suggested conservation actions. Any major discrepancies in opinion were incorporated into the final report.
- The report focuses on the habitats, threats, and conservation actions relevant for the migratory areas of the monarch across the breeding range of the eastern and western populations. Monarch overwintering sites (found in California and Baja and central Mexico), including the conservation actions and threats specific to those habitat types, were not considered in this report.
- To protect sensitive information and/or opinion, responses that reveal the person or company were redacted from both the Expert Survey and Company Survey results presented in this report.
- The conservation actions included in this report are based on the best available science and current state of knowledge related to monarch biology, the threats they face, and actions understood to help reverse their population declines. Because basic and applied research on monarchs is active and evolving, the information and conclusions in this report are limited to the time period when the report was developed.
- Discussing power companies' monarch conservation actions related to managing for climate change is outside the scope of this report.

3
MEET THE MONARCH

Monarch Butterfly Biology

Life Cycle

The life cycle of a monarch butterfly (*Danaus plexippus plexippus*) includes four distinct stages: egg, larva (caterpillar), pupa (chrysalis), and adult (see Figure 3-1). Adult female monarchs lay eggs on milkweed (*Asclepias* spp.) and related genera, and 3–5 days later the caterpillar hatches. The caterpillars rely on milkweed for food as they develop through five instars, stages between molts as the caterpillars grow. Milkweed also provides the caterpillars with cardenolides—toxic compounds that make them unpalatable to many vertebrate predators such as birds. Their bright, aposematic coloration warns predators of their toxicity. However, parasitism and predation of caterpillars by invertebrates can be high—with less than 10% of eggs typically surviving to adulthood (Nail et al., 2015). It typically takes caterpillars 10–14 days to reach the fifth instar, after which they will form a green chrysalis (pupa) with gold trim attached to milkweed, surrounding vegetation, or other structures. Within 9–14 days, the adult butterfly emerges and will hang upside down to expand and dry its wings before it can fly. When their wings are dry, monarchs will fly off to find nectar and to mate, with females then searching for milkweed upon which to lay their eggs. It takes approximately 1 month for a monarch to develop from an egg to adult (depending on temperature and other factors). Multiple generations are produced over the spring and summer, with the fall generations migrating to overwintering sites. Spring and summer generations typically live 2–5 weeks as adults, while overwintering butterflies may live 6–9 months.

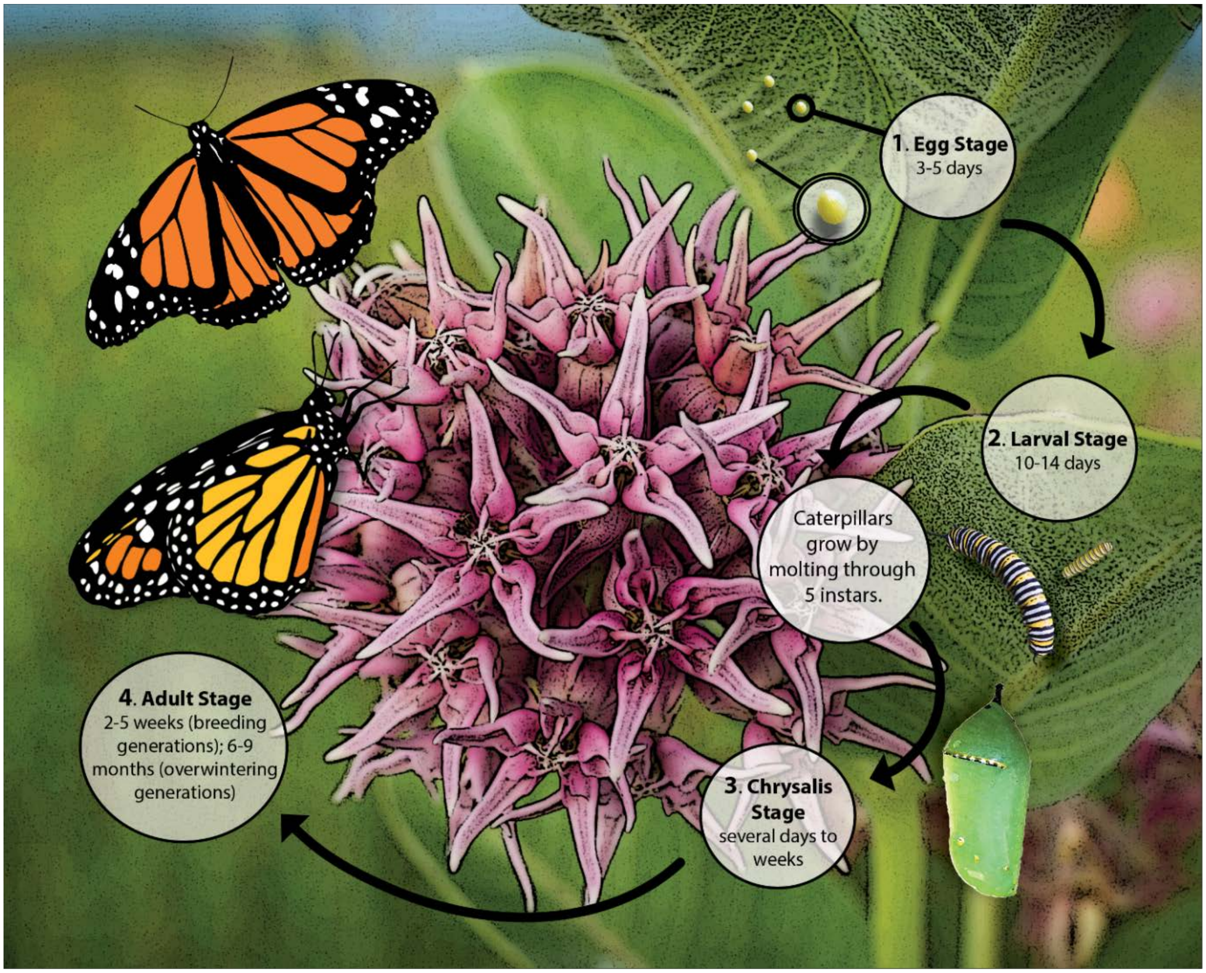


Figure 3-1
Monarch life cycle (Credit: Xerces Society)

Distribution and Migration

Monarch butterflies are found throughout North America. There are also populations outside of North America, found in northern South America, Hawaii, other Pacific Islands, Australia, New Zealand, Spain, and Portugal, though most of these are likely the result of introductions made in the nineteenth century or earlier (Vane-Wright, 1993; Zhan et al., 2014). In North America, monarchs migrate hundreds or thousands of miles from their breeding grounds found across the United States and southern Canada (up to about 50 degrees north) to their overwintering grounds in both Mexico and California (see Figure 3-2). The *eastern monarch population*—defined as monarchs that breed east of the Rocky Mountains—migrates to and overwinters in high-elevation oyamel fir forests in the states of Mexico and Michoacán in central Mexico. The *western monarch population*—which breeds west of the Rocky Mountains—migrates to and overwinters in forested groves along the Pacific coast stretching from Mendocino, California, south into western Baja, Mexico. The eastern and western populations are not genetically distinct (Lyons et al., 2012; Zhan et al., 2014), and tagging studies show that at least some portion of monarchs from the West—particularly the Southwest—migrate to central Mexico where they overwinter alongside eastern monarchs (Morris et al., 2015). In addition to these major overwintering sites, small numbers (under 100 butterflies at any one site) of butterflies overwinter in the Saline Valley of California (Xerces Society Western Monarch Thanksgiving Count, 2018), Sonoran Desert near Phoenix, Arizona (Morris et al., 2015), and the Mojave Desert near Lake Mead, Nevada. There are also smaller, non-migratory populations in Florida and other parts of the extreme southern United States.

Each spring, monarchs leave their overwintering grounds to seek out milkweed in their spring and summer breeding range—which is broadly distributed across the United States as far north as southern Canada. In the East, monarchs migrate from Mexico to the southern United States, lay their eggs, and die. Their offspring expand the range of monarchs northward, with many flying to the Upper Midwest and Northeast and some to Canada. Monarchs subsequently produce second, third, and fourth generations in the Upper Midwest, Northeast, and Canada. In the West, monarchs leave the overwintering grounds along the California coast to breed in California and adjacent Nevada and Arizona (Dingle et al., 2005; Cheryl Schultz, unpublished data). The population expands to Oregon, Washington, Idaho, and British Columbia (as well as other western states) over successive generations—the last of which migrates back to overwintering sites in the fall.

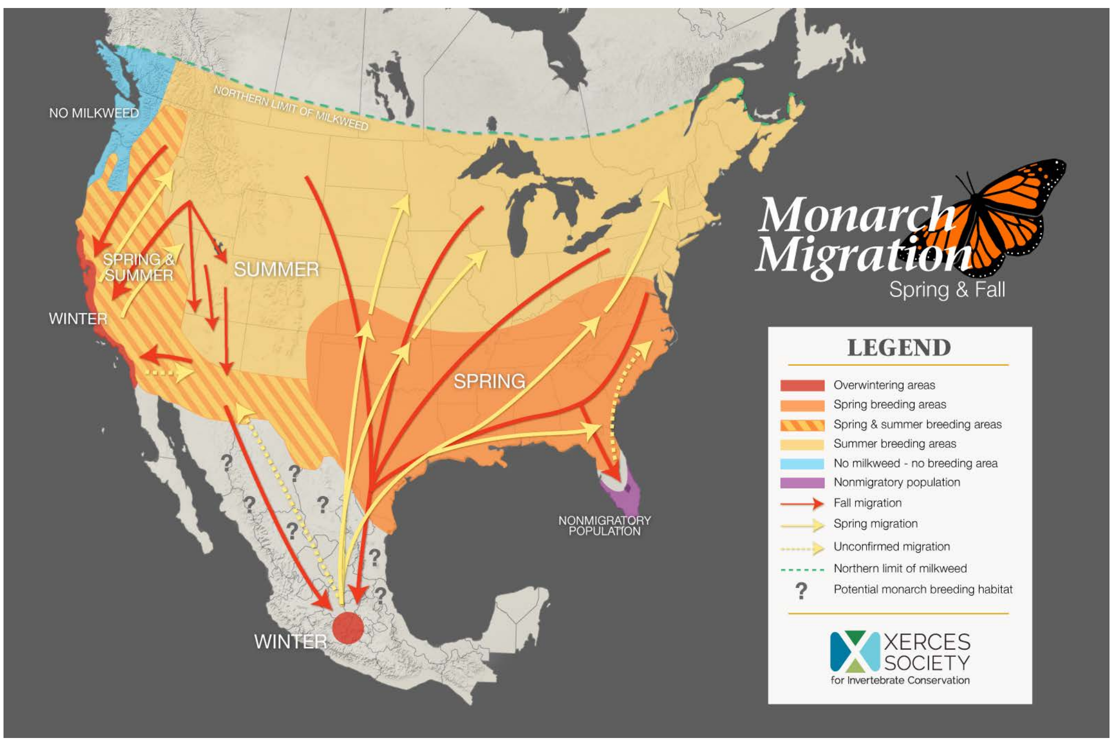


Figure 3-2
Monarch migration and distribution in North America (Credit: Xerces Society)

As fall approaches, native milkweeds senesce, and the last monarchs to reach adulthood focus on finding nectar and starting the journey to the overwintering grounds rather than reproducing. The migratory generation(s) use the earth's magnetic fields, a time-compensated sun compass, and likely other cues to start flying south (Heinze and Reppert, 2011). Monarchs begin migration in a dispersed manner but develop into aggregations as they fly south in the eastern United States, gathering into large numbers in Oklahoma, Texas, and other southern states on their way to Mexico. Aggregations are less commonly observed in the western United States but are sometimes observed in nectar- and water-rich areas in the arid Southwest. Dingle et al. (2005) found a strong association of monarch collection records and proximity to rivers and proposed that western monarchs use rivers as major migratory corridors because they provide more reliable sources of water, nectar, and trees to roost in at night. There are anecdotes of fall-migrating monarchs in the East forming temporary aggregations in trees along rivers or lakeshores and in suburbia to spend the night or take shelter from storms. Once the butterflies reach their overwintering grounds—typically in September or October in California; November in central Mexico—they form clusters with other butterflies and settle in for the months ahead. An isotopic study has shown that monarchs at California overwintering sites arrive from all regions of the West—including a large portion coming from interior western states such as Idaho (Yang et al., 2016). Overwintering monarchs are typically in reproductive diapause—not mating or laying eggs—to conserve their fat for survival and spring dispersal in February or March. One exception is the coastal areas of southern California, the Gulf States, and Florida where the widespread planting of nonnative, tropical milkweed (*A. curassavica*) and a mild winter climate have led to year-round breeding and partial abandonment of migratory behavior. Monarchs are also known to breed nearly year-round on native, evergreen milkweeds in parts of Arizona.

Monarch Habitat

Following are the principal features of high-quality breeding and migratory monarch habitat:

- Native milkweeds to provide food for monarch caterpillars and nectar for adults (see Appendix C for resources including those for photos of milkweed).
- Flowers, ideally a diversity of native species with overlapping flowering phenologies to provide nectar for adults.
- Protection from herbicides and insecticides (see Herbicides discussion for more information on monarch protection during vegetation management).

Other features of high-quality monarch habitat include places that are safe from high levels of disease and features such as trees and shrubs for shade and roosting—but these vary in importance by geographic location and throughout the migratory cycle and are not well-studied.

Breeding habitat consists, at a minimum, of milkweed but often includes other flowers for nectar that provides fuel for adult butterflies. Migrating habitat includes flowers, which provide nectar for adults during the spring and/or fall migration periods, as well as roosting habitat, which is thought to be particularly important during the fall migration; monarchs are often observed using trees to spend the night or wait out inclement weather. Milkweed is not necessary during fall migration because adult butterflies are typically in reproductive diapause.

Monarch breeding and migration habitat are often synonymous—a field with milkweed and flowers provides both places to lay eggs and nectar for migrating adults. For this reason, breeding and migratory habitat are frequently undifferentiated in this report and in other resources (often called *breeding habitat*). However, there are some important exceptions. For example, monarchs may nectar on abundant blooms of late season rabbitbrush (*Ericameria* spp. and *Chrysothamnus* spp.) or sunflowers (*Helianthus* spp.) in areas lacking milkweed, or river corridors may be used more extensively during fall migration when plants far from water may have senesced. Recognizing that differences exist in some areas, the management and restoration recommendations for both breeding and migratory habitat are generally quite similar and are grouped together in this report as *monarch habitat*.

Milkweeds

The plants that have been recorded as hosts of monarch caterpillars in the lower 48 states are species of five genera of milkweeds: *Asclepias*, *Cynanchum*, *Funastrum*, *Gonolobus*, and *Matelea*. The genus *Asclepias* is by far the most diverse, widespread, and well-known of these genera and is the most important genus for monarchs in the United States. There are 77 *Asclepias* species native to the United States (BONAP, 2014), and at least 31 have been documented as larval hosts for the monarch (Malcolm and Brower, 1986; HOSTS online database; Ray Moranz, personal observation). All plants in the other four native milkweed genera are vines. Most of these genera are best represented in the southern United States, but *Cynanchum laeve* (a known larval host) occurs naturally as far north as Chicago.

Milkweeds are named for the milky sap that most milkweed species possess, which contains latex and complex chemicals (cardenolides) that make the plants unpalatable to most animals. The plants have fleshy, pod-like fruits (follicles) that split when mature, releasing the seeds. White, fluffy hairs (the pappus) are attached to each seed, and these hairs facilitate wind dispersal of the seed. One exception is aquatic milkweed, *Asclepias perennis*; its seeds lack hairs and are dispersed by water.

Milkweed species have differing life histories, including evergreen perennials and short-lived deciduous perennials. Most native milkweeds are the latter; they typically grow in the spring and summer and then senesce and remain dormant for the winter, reemerging the next spring. However, in the desert southwest, several native milkweed species grow and flower year-round such as rush milkweed (*A. subulata*) and whitestem milkweed (*A. albicans*). Nonnative species such as tropical milkweed (*A. curassavica*) and balloon plant (*Gomphocarpus* spp.) can also grow and flower year-round. In the West and Deep South, some native milkweeds may emerge as early as March and continue to grow into November, depending on the species, habitat, water availability, and elevation. Research suggests that monarch adults may be selecting milkweed plants to lay eggs on based on the plant's phenology—more eggs are laid on young plants and those that are flowering versus fruiting or beginning to senesce (for example, Zalucki and Kitching, 1982).

Common milkweed (*Asclepias syriaca*) is the most often-used milkweed in the North Central and Northeastern parts of the monarch's range, whereas green antelopehorn (*A. viridis*) is important in the South Central, and narrow leaf (*A. fascicularis*) and showy milkweed (*A. speciosa*) are important across much of the West. However, in some areas and habitats, other milkweeds are of greater importance (for example, swamp milkweed [*Asclepias incarnata*] in marshes and along pond edges).

Milkweeds vary widely in flower color, growth form, leaf structure, and phenology, but the flower and fruit structure are similar among all species. Milkweed flowers grow in clusters on stalks. Each flower has five colorful hoods, nectar-storing structures, which extend upward like points on a crown. Milkweeds produce copious amounts of high-quality nectar to attract insect pollinators; because pollen is inaccessible for insect consumption, nectar is the only reward.

Milkweed fruits are fleshy pods or follicles that split at maturity to release windborne seeds equipped with fluffy white hairs (floss, pappus, coma, or silk) to catch the wind and aid in dispersal. Another similarity among all milkweed plants is that they secrete a white or clear latex when plant tissue is damaged. The flower, fruit structure, and latex are all important features used to identify a species of milkweed. To learn to identify milkweed species in your region, you can use guides such as the following:

- State-specific milkweed species lists, species profiles, an interactive identification tool, and occurrence records are available through the Western Monarch Milkweed Mapper website for 11 Western states.
- Region-specific milkweed species lists and profiles developed by Xerces, NRCS, Monarch Joint Venture, and Monarch Watch are available on their websites. Milkweeds are also host to a diverse specialist insect community (Van Zandt and Agrawal, 2004; James et al., 2016), and management to promote milkweeds benefits a variety of other insect species (Zaya et al., 2017). Milkweeds provide nectar resources important for supporting a wide range of pollinators such as native bees, honey bees, butterflies, beetles, flies, and hummingbirds as well as other insects that offer benefits to the agricultural sector (Tooker et al., 2002; Borders and Lee-Mäder, 2014). Milkweed plants may also support insects that are important forage for birds such as the greater sage-grouse (Dumroese et al., 2016) and provide nesting material for some songbirds.

Nectar Plants

Unlike monarch caterpillars that have specific host plant needs, adult monarchs feed on nectar from a variety of blooming plants. Some plant families are more frequently used as nectar sources than others (*Asteraceae, Apocynaceae*); even within those families, monarchs may exhibit strong preferences for some species over others. For example, monarchs may prefer nectaring on milkweed, even when other flowering plants are available (Morris et al., 2015). Flower nectar is important for fueling all adult monarch activities (including breeding, migration, and overwintering), and the quality and quantity of available nectar sources in the landscape are thought to have a population-level impact on monarchs. Late-blooming floral resources such as rabbitbrush (*Chrysothamnus* and *Ericameria* spp.), mule-fat (*Baccharis* spp.), sunflowers (*Helianthus* spp.), goldenrods (*Solidago* spp.), blazing stars (*Liatris* spp.), asters (*Symphyotrichum* spp.), and wingstems (*Verbesina* spp.) can be especially important to late fall generations, which need large quantities of nectar to generate the lipids (fats) that will fuel their migration journeys and sustain them until the spring breeding season the following year.

Overwintering Sites

The majority of monarch overwintering sites in central Mexico are contained within the Monarch Butterfly Biosphere Reserve, a UNESCO World Heritage Site northwest of Mexico City. You can learn more about these sites on the UNESCO website and through World Wildlife Mexico's website.

Monarch overwintering sites in coastal California and Baja, Mexico along the Pacific Ocean include over 400 sites, with no comprehensive legal protection. You can learn more about these sites on the Xerces' Western Monarch Thanksgiving Count website. See Figure 3-3 for a map of California overwintering site locations.

Because of the geographic specificity of overwintering habitat, conservation of this habitat type does not have as wide an application to the larger set of electric power companies in North America compared to migratory habitat and was therefore considered outside the scope of this report. A database, including spatial information and encompassing overwintering site location, condition, ownership, and the number of butterflies hosted is available for planning and research purposes from the Xerces Society.

Figure 3-3
California and Baja, Mexico monarch overwintering site locations. Individual sites denoted by teal circles.

Priority Areas for Habitat Conservation and Restoration

Monarch breeding and migratory habitat is found broadly over the vast majority of the lower 48 states and into southern Canada. Northern Mexico is also an important migratory habitat for monarchs on their way to and from the Mexican overwintering sites. The Midwest has long been considered the most important area for producing the monarchs that make it to Mexico (Brower, 1995; Wassenaar and Hobson, 1998); however, more recent isotopic work (Flockhart et al., 2017) has shown that although the Midwest does typically contribute 38% of monarchs that overwinter in Mexico, significant amounts are also coming from other regions: Northeast (17%), Great Lakes (15%), Northern Plains (12%), Southern Plains (11%), and Southeast (8%). On a per acre basis, the Northeast Region (which is vastly smaller than the Midwest as defined in the study) had similar monarch production to the Midwest; the Southern Plains is also critical because this region produces the first generation of monarchs—which then continues north to produce the migratory generation. A similar isotopic study in the West (Yang et al., 2016) found that monarchs that overwinter in California arrive from all regions of the West. This includes a large portion coming from interior western states such as Idaho as well as the Great Basin, Pacific Northwest, and California. No isotopic studies to date have bridged their analyses across the continental divide to better clarify the connection between eastern and western populations.

These findings lead to the conclusion that it is important to conserve monarch habitat in all the regions where it occurs—nearly all the lower 48 states and into southern Canada.

In addition, modeling in the West has identified areas with notable concentrations of potentially highly suitable habitat in California as well as in southern Idaho and eastern Washington; smaller areas are evident across northern Nevada, southern Arizona, parts of Utah, most low-elevation lands in Oregon excluding the coast, and other areas (see Figure 3-4) (Dilts et al., 2018). The Central Valley and adjacent foothills of the Sierra Nevada and Coast Range of California are particularly important because monarchs likely pass through these areas on both their spring and fall migrations to and from interior and northwestern states. It is recommended to consider both milkweed and monarch breeding models and uncertainty models when making decisions about which areas are the highest priority for monarchs in a particular region (Xerces Society, 2018).

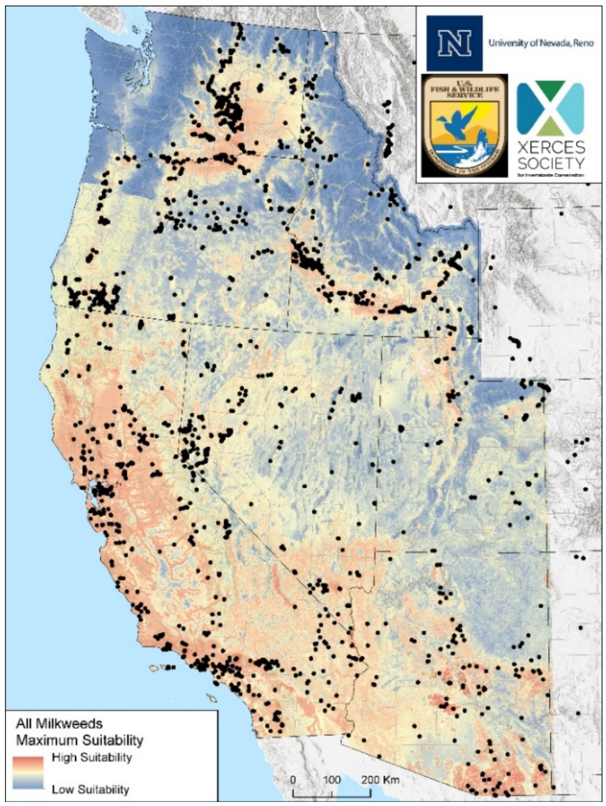


Figure 3-4
Maximum milkweed suitability (Dilts et al., 2018). Black dots indicate geographically high-accuracy occurrences used in habitat suitability modeling.

Xerces' approach to monarch habitat conservation and restoration has been informed by the best current science and the Expert Survey in this project and is summarized by the following priorities, in order of importance:

1. Identify, protect, and manage existing habitat to maintain its value for monarchs.
2. Enhance existing habitat (if needed and appropriate) to improve its value for monarchs.
3. Restore habitat in areas where it occurred historically but has been lost.

All experts surveyed said that protecting existing monarch habitat is very beneficial.

In many natural or semi-natural areas, more milkweed may not need to be planted; rather, monarch breeding sites should be identified, protected, and managed in a way that benefits monarchs. However, in key breeding areas that have been highly modified by human activity, planting milkweed and other species may be an appropriate strategy—depending on the history of the particular site and the current land use. In general, restoring breeding habitat in agricultural landscapes that have been converted from native grassland or rangeland use (where milkweed historically occurred but has been lost) is recognized as a critically important strategy to monarch population recovery (Thogmartin et al., 2017b). For these reasons, areas with a high density of row crop agriculture or rangeland have been particularly targeted in national monarch conservation efforts (for example, USDA National Resource Conservation Service), including the flyway stretching from the Southern Plains north into the Upper Midwest. Other areas that may benefit from breeding habitat restoration include urban and suburban areas, roadsides, and other rights-of-way—all of which are important parts of the "all hands on deck" approach to restoring monarch habitat throughout the butterfly's range (Thogmartin et al., 2017a). Restoring migratory habitat by planting nectar resources, particularly native species that are spring- and/or fall-blooming, is widely encouraged in all geographic areas. Risk of insecticide exposure should be considered when undertaking breeding and migratory habitat restoration in all settings.

As climate change impacts monarch habitat, prioritizing the conservation and restoration of areas most likely to be resistant and resilient is also a wise use of resources. Northern latitudes (for example, southern Canada) and higher elevation areas, for example, may become more important during the summer breeding season as the climate warms (for example, Lemoine, 2015).

Although planting milkweed is generally viewed as positive for monarch conservation, there are two areas in the western United States where planting milkweed is not a recommended strategy. According to the best available records, native species of milkweed did not historically grow west of the Cascade Crest in Washington and parts of western Oregon or along most central and northern parts of the California coast. In areas west of the Cascade Crest in Washington and parts of western Oregon, monarchs only pass through in relatively small numbers or in some years. For this reason, planting milkweed in these areas of the Pacific Northwest is not a recommended monarch conservation strategy—but it is also not a major conservation concern. However, planting milkweed close to overwintering sites (within 5 miles of the Pacific coast) north of Santa Barbara in Central and Northern coastal California where it did not occur historically (see Pelton et al., 2016 for additional information) is **not** recommended. This may interrupt the natural behavior of fall-migrating and overwintering monarchs by encouraging them to breed at inappropriate times of year and spread disease (Satterfield et al., 2016). Instead of planting milkweed in these areas, plant fall-, winter-, and spring-blooming native flowering plants that provide nectar resources for monarchs and other pollinators.

Conservation Status

Every fall, millions of monarchs arrive to overwinter in the forested mountains in central Mexico, and hundreds of thousands gather along the Pacific coast in California; however, their numbers today are a small fraction of the butterflies that aggregated in the past. The overwintering population in Mexico has declined by more than 80% since the 1990s and has a quasi-extinction risk of 11–57% in the next 20 years (Semmens et al., 2016). The overwintering population in California has declined 97% since the 1980s with a quasi-extinction risk of 72% in the next 20 years (Schultz et al., 2017). In 2018, the population hit an all-time low of 28,429 butterflies; a mere 0.6% of its historic population size (Xerces Society Western Monarch Thanksgiving Count, 2019). Declines have also been documented in monarch breeding populations during the spring and summer in California (Espeset et al., 2016).

Monarchs and their breeding, migratory, and overwintering habitats have no comprehensive legal protection in the United States as of the writing of this report (fall 2018). They are being considered for protection under the federal Endangered Species Act; a listing decision is expected in June 2019.

Threats to Monarchs

Monarch butterfly populations in North America face multiple stressors across their range, including habitat loss, herbicides, insecticides, and climate change as well as parasites, diseases, and predators.

This section summarizes threats to monarchs broadly across the landscape and are not specifically related to electric power companies.

Habitat Loss

Habitat loss is an important driver of the monarch population decline (Pleasants and Oberhauser, 2013; Flockhart et al., 2014; Stenoien et al., 2018; Saunders et al., 2017; Thogmartin et al., 2017b; Zaya et al., 2017; Crone et al., in review). The loss of milkweed in agricultural fields due to changing agricultural practices has reduced breeding habitat for monarchs (for more information, see the Herbicide Use section of this report). Milkweed and nectar plants have also been lost through conversion of grasslands (for example, rangelands or idle cropland in conservation programs) to annual crop production; for example, 1.3 million acres of grassland were converted in the Northern Corn Belt between 2006 and 2011 (Wright and Wimberly, 2013); nationwide, 2.98 million acres of uncultivated land were converted to cropland from 2008 to 2012 (Lark et al., 2015).

In addition to habitat loss in agricultural landscapes, water management, development, and rangeland and natural areas management can also affect the quality of monarch habitat. In arid areas, highly modified water movement such as dams and irrigation and the associated decline and degradation of natural wetlands has altered the availability of mesic habitats in which wetland-dependent milkweed and nectar species grow. Urban and suburban development continues to convert natural habitat into highly modified landscapes; the loss of milkweed and nectar plants in these natural habitats are likely persistent threats to monarchs. In addition, how we manage remaining natural areas matters. Excessive herbicide spraying, mowing, or grazing can affect the value of existing habitat for monarchs by reducing nectar and milkweed availability. Invasive nonnative plants, including those designated as noxious weeds (referred to as *invasive plants* hereafter), reshape native habitat by outcompeting existing vegetation, often to the detriment of native and naturalized nonnative plant species that monarchs and other pollinators rely on. Although some invasive plants (for example, Canada thistle) can provide nectar for monarchs, the dominance of those weeds can be detrimental to monarchs overall by limiting the availability of nectar plants or milkweed across the growing season.

Habitat loss at overwintering sites due to logging and development in both Mexico and California is also a major concern and has been linked with monarch population declines as well

(Brower et al., 2012; Thogmartin et al., 2017b; Crone et al., in review). Further discussion of the threats to overwintering sites is outside the scope of this report. Refer to the *State of the Overwintering Sites* report (Pelton et al., 2016) for more information about sites in California.

"Weeds" and Monarchs

The term ***weed*** is applied to a plant that is undesirable in a particular location and can be used subjectively. ***Noxious weeds*** are designated by states and/or the federal government as species detrimental to human health, ecosystem health, agriculture, or property. ***Invasive plants*** are species that possess certain traits that allow them to be highly adaptable and successful invaders, often aggressively outcompeting native plants. Invasive species are most often introduced nonnative species that lack natural enemies within their new range, but native species can also become invasive (for example, Eastern red cedar invades and degrades prairies and other open grasslands that support monarchs). Invasive plants and noxious weeds pose a risk to monarchs by degrading their habitat, reducing milkweeds and nectar sources. Broadly, invasive plants and noxious weeds pose a serious threat to ecosystems, significantly altering plant communities and impacting the animals that depend on them as well as changing ecosystem processes, soil chemistry, and fire regimes (DiTomaso, 2000; Duncan et al., 2004). Invasive alien plants are direct drivers of changes in ecosystems and declines in biodiversity (Millennium Ecosystem Assessment, 2005).

Herbicide Use

Broadly, indirect effects of herbicides are more likely to have the greatest adverse impacts on monarchs than direct toxicity. Indirect impacts of herbicides on monarchs can include reduction or elimination of milkweed host plants or nectar plants. The rise of herbicide-resistant row crops, in particular, has been linked to large-scale declines in milkweeds in the United States east of the Rocky Mountains, with negative impacts on the eastern monarch population (Pleasants and Oberhauser, 2013; Flockhart et al., 2014; Stenoien et al., 2016; Saunders et al., 2017; Thogmartin et al., 2017b; Zaya et al., 2017). Although the effects of the loss of milkweeds due to increased herbicide use on herbicide-resistant crops has been better documented in the eastern United States, an increase in herbicide use in the western United States has also occurred in the past four decades (USGS Pesticide National Synthesis Project) and may be influencing the amount of milkweed and nectar resources available to monarchs in the West. A recent study (Crone et al., in review) pointed to land use changes, including the increase in herbicide use, as potentially one of the primary drivers of the western monarch population's decline. Because the monarch decline has been linked with herbicide practices, herbicide practices that contribute to the large-scale loss of milkweed and important nectar resources should be avoided. Some herbicide uses can also contribute to declines in nectar plants that would negatively affect monarchs (Bohnenblust et al., 2016).

The majority of glyphosate use has been on corn and soy fields (Benbrook, 2016), and associated milkweed losses have been well-documented in Midwestern row crop fields (Hartzler, 2010; Pleasants and Oberhauser, 2013) rather than natural areas (Zaya et al., 2017). In some of the monarch's key breeding areas of the West, including areas of intensive agriculture—the Central Valley of California, the Snake River Plain in Idaho, and the Columbia Plateau in southeastern Washington and northeastern Oregon—glyphosate use has also increased dramatically since the 1990s (USGS Pesticide National Synthesis Project).

Glyphosate is not the only herbicide that kills milkweed or harms monarch habitat—it is simply the most widely used. Other herbicides can also be used over large swaths of land. Dicamaba and 2,4-D, to which some newer genetically modified crops are engineered to be resistant, may be of particular concern because of their high potential to move off-site into natural areas. In general, agriculture has trended toward replacing tillage—whose soil-disturbing qualities benefit many milkweed species—with herbicide use, resulting in chemically managed agricultural landscapes devoid of weedy edges or understories that may once have provided monarch habitat. Herbicide use has also been linked to local (Saunders et al., 2017) and population-level declines for both the East and West (Thogmartin et al., 2017b; Crone et al., in review). The relative importance of the loss of milkweed, compared with other stressors, is an area of active research (for example, Davis and Dyer, 2015; Dyer and Forister, 2016; Espeset et al., 2016; Inamine et al., 2016; Pleasants et al., 2016; Agrawal, 2017; Pleasants et al., 2017; Thogmartin et al., 2017b; Crone et al., in review).

Increasing the complexity of the herbicide discussion, in some cases herbicide use can support monarchs and other pollinators. For example, use of herbicides to control invasive plants or to control encroaching woody vegetation to maintain an open herbaceous plant community may support monarchs by suppressing undesirable plants that displace nectar plants and milkweeds. This is further discussed in Section 6, Conservation Actions for Herbicides and Invasive Species Management.

Insecticides

The term *pesticide* is an umbrella term and includes insecticides, herbicides, miticides, fungicides, and even rodenticides. The U.S. Environmental Protection Agency defines a *pesticide* as "any substance or mixture of substances intended for preventing, destroying, repelling or mitigating any pest; use as a plant regulator, defoliant, or desiccant; or use as a nitrogen stabilizer."

Of the various pesticide groups, insecticides are most likely to directly harm monarchs. Many commonly used insecticides are classified as either moderately or highly toxic to terrestrial insects and are broad spectrum—able to kill or otherwise harm a variety of beneficial insects, including adult and juvenile butterflies. Because monarchs migrate over a large and diverse landscape, they can be exposed to insecticides as they move through or visit agricultural, residential, and natural areas.

Systemic insecticides, such as neonicotinoids, are of particular concern due to their persistence in the environment, leading to exposure months to years after a treatment. Because these chemicals are systemic—they are taken up by plants—they can make the pollen, nectar, and leaves toxic to insects that consume these parts of the plant. Neonicotinoids are the most commonly used class of systemic insecticides and include imidacloprid and clothianidin, which have been shown to have sublethal and lethal effects on developing monarchs (Krischik et al., 2015; Pecenka and Lundgren, 2015). Correlative threats analyses for both western and eastern monarchs have identified a negative association between neonicotinoid use in the breeding period and monarch population size (Thogmartin et al., 2017b; Crone et al., 2018, in review).

Insecticides used for mosquito control can also impact monarchs and other butterflies. Both monarch larvae and adults suffer mortality when directly exposed to the insecticides permethrin and resmethrin residues on host plants (Oberhauser et al., 2006; Oberhauser et al., 2009).

Insecticide applications for mosquito control have also been linked to declines in other butterfly species, especially butterfly populations in Florida (for example, Eliazar and Emmel, 1991; Salvato, 2001; Carroll and Loye, 2006).

Climate Change

Climate change has been identified as one of the greatest risks to biodiversity worldwide (Maclean and Wilson, 2011), in part due to the associated changes in seasonal temperatures, altered precipitation patterns, rising sea levels, and higher frequency of extreme weather events such as storms, floods, and droughts (IPCC, 2014). Climate change undoubtedly has and will continue to impact monarchs—there have been multiple studies showing shifts and reductions in breeding and overwintering habitat suitability in the United States and Mexico under future climate scenarios (for example, Oberhauser and Peterson, 2003; Batalden et al., 2007; Sáenz-Romero et al., 2012). Although relatively little is known about how climate change will impact monarchs in their breeding range, a growing number of studies identify four primary concerns for pollinators in general: 1) phenological divergence of pollinators and the plants they rely on, 2) range shifts that lead to spatial mismatches between plants and pollinators, 3) reduction in quality and quantity of nectar and pollen, and 4) extreme weather events such as flooding, storms, and drought. Climate change is also expected to be a growing source of stress for species—such as monarchs—that are already impacted by habitat loss, high pathogen loads, small population sizes, or the many other threats facing pollinators today.

Climate change is expected to lead to earlier spring snowmelt, reduced snowpack, and increases in drought—and extreme events are projected to become more common, including storms, floods, large forest fires, and prolonged heat waves (Wuebbles et al., 2017). Larger, more frequent wildfires can remove nectar and floral resources from the landscape and may directly kill adult and immature monarchs. In 2017 alone, more than 10 million acres burned across the United States, well above the normal average (National Interagency Fire Center).

Drought and extreme weather events such as storms can negatively impact monarchs by influencing host and nectar plant survivability and palatability or by causing mass monarch die-offs, such as those observed after winter storms at monarch overwintering sites in California and Mexico (Brower et al., 2017). Rainfall and soil moisture both affect a plant’s ability to produce nectar and nectar content (Schweiger et al., 2010). Drought can decrease the availability of nectar in the short term and can decrease the availability of nectar plants in the long term. Milkweed distributions are expected to shift northward under both moderate (1–3°C increase) and severe (2–6°C increase) climate warming scenarios, potentially leaving large milkweed-less areas that monarchs will need to cross as they leave overwintering sites in the spring (Lemoine, 2015).

Other threats to monarchs that relate to climate change may include air pollution (for example, ozone), changes to abiotic and biotic cues used by monarchs for migration, and elevated CO_2 levels (Malcolm, 2018 and references therein) as well as increased pesticide use in agricultural areas (for example, Chiu et al., 2017; Taylor et al., 2018). As with all threats to monarchs, climate change impacts should be viewed within the context of multiple drivers of decline interacting over large spatial and temporal scales. Furthermore, not all climate change impacts are necessarily negative. In a field-based insect metacommunity experiment in Southern Ontario, warming treatments (an average of 2.7°C warming during the day) increased monarch survival (Grainger and Gilbert, 2017).

Parasites, Diseases, and Predators

Like other insects, monarchs are susceptible to a wide range of parasites, diseases, and predators. As the impact from other threats has already reduced the population significantly, disease, predator, and parasite loads may be additional sources of stress. Monarchs are most vulnerable in their egg and larval stages, and although the overlap of monarchs with predators and parasitoids varies over time and space, relatively few individuals make it to the adult stage. Nail et al. (2015) found less than 10% of eggs become butterflies. Both larval and adult monarchs use warning coloration and unpalatable sequestered cardenolides to deter predators. However, several species have evolved to avoid or minimize the effects of these toxic chemicals. Numerous invertebrate species prey on immature and adult monarchs throughout their range, including spiders, lacewings, mantids, yellow jackets, and assassin bugs. Avian and mammalian predators have been documented feeding on monarchs at overwintering sites in California and Mexico (Brower and Calvert, 1985; Xerces Society, unpublished data).

Across the breeding range, introduced species are becoming more of a concern for monarchs. The red imported fire ant (*Solenopsis invicta*) has been documented throughout the Southeast and Texas and continues to spread north and west; it is now known from southern California, Arizona, and New Mexico (Korzukhin et al., 2001). These ants have been documented to cause 100% mortality of monarch butterfly eggs and larvae in some circumstances. The European paper wasp (*Polistes dominulus*), another introduced species, feeds primarily on Lepidoptera caterpillars (Liebert et al., 2006). Some evidence suggests that these nonnative wasps may consume some sensitive butterfly larvae such as the monarch butterfly (De Anda et al., 2015). Invasive multicolored Asian lady beetle (*Harmonia axyridis*) larvae also feed on monarch eggs and larvae (Koch et al., 2005), and other introduced biocontrol agents such as Chinese mantids (*Tenodera sinensis*) have been documented feeding on monarch as well (Rafter et al., 2013).

Several parasites and parasitoids of monarchs have been identified, including wasps, flies, and the protozoan parasite *Ophryocystis elektroscirrha* (OE). Tachinid flies may be the most prevalent monarch parasitoid (Oberhauser et al., 2017). OE can decrease larval survivorship, affect wing size, cause wing deformities and difficulties during eclosion, shorten monarch life spans, decrease lifetime fecundity, or even result in direct mortality (Altizer and Oberhauser, 1999; Bradley and Altizer, 2005; De Roode et al., 2009; Bartel et al., 2011; Satterfield et al., 2016). OE spreads through dormant spores deposited by infected females onto milkweed host plants and monarch eggs; newly hatched larvae then ingest the spores, which move into the caterpillar's gut where they begin to lyse. Although low levels of parasitism are normal in wild monarch populations, much higher OE loads have been associated with non-migratory or winter breeding monarch populations (such as those in Florida, other Gulf states, and southern California). OE is of particular concern when nonnative, evergreen milkweed is planted along the Gulf Coast or near overwintering sites in coastal California because it does not die back in the winter and may lead to interruption of the monarchs' winter diapause. Satterfield et al. (2016) found that OE levels were nine times higher in winter breeding monarchs on nonnative, tropical milkweed than those in reproductive diapause in California.

4
ELECTRIC POWER COMPANIES AND THEIR ROLE IN MONARCH CONSERVATION

Power companies generally recognize that monarch butterflies are a culturally and ecologically significant species and are interested in undertaking relevant and meaningful conservation efforts.

The power companies that participated in this research (see Table 2-1) indicate interest in supporting monarchs based on their ecological and cultural value, regardless of whether the species receives federal or state regulatory protection. As demonstrated in the company case studies in this report, some companies are already taking actions to support pollinators, including monarch butterflies; others are considering actions in the near future.

It is important to remember that although there is interest in pollinator and monarch conservation, electric power companies are obligated by policy, regulation, and customer expectations to provide safe, reliable, and affordable electricity—this is their core mandate. Commitments that go beyond what is required to meet this core mandate often fall into the voluntary "sustainability" realm and need to be justified with a business case, including consideration of trade-offs (Fox and Scott, 2018). It would be unacceptable, for example, to prolong an electric power outage in order to protect pollinator habitat. Companies will be obligated to protect people, then electric service, then the monarch—even if the monarch is federally protected.

The question for monarch conservation by power companies is, "Where are the best opportunities to support monarchs, given the barriers and constraints power companies face?"

The electric power industry is undergoing an enormous transition as companies manage aging infrastructure, cybersecurity threats, adoption of renewable energy, aggressive end-use energy efficiency programs, electrification of systems that previously used non-electric fuels, and responding to a new generation of customer demands. In relation to pollinators and monarchs, with the retirement of coal-fired power plants and the increasing use of wind, solar, and other generation fuels, the specific way that the industry interacts with biodiversity is changing due to the associated habitat footprint that is evolving. Although the terrestrial footprint of the electric system has largely been stable for the last three decades, this past footprint will likely change rapidly over the next 10 years, bringing changes to the underlying habitats involved.

In considering habitat management opportunities for power companies, it is necessary to understand the specifics of the land asset types they manage and any associated legal, regulatory, or business barriers on those sites. Further, different land asset types may have various applicable land management approaches. For example, transmission lines have a specific requirement to keep vegetation clear of the electric lines. Electrical substations have access and visibility issues that inform the acceptable vegetation options on-site. Properties around power plants may not have the overhead clearance requirements or visibility concerns, but there are still access issues that need to be considered—particularly for nuclear power plants to comply with NERC licensing requirements. Solar sites need to consider shading and panel damage resulting from vegetation management equipment, among other issues. Each asset type has particular considerations, making generalized assessment of conservation actions for power companies less useful.

If the monarch is listed under the federal Endangered Species Act (or through state listings), regulatory implications may change what power companies can do in monarch habitat. Because no listing decision has been made at the time of publication, speculating on regulations that the U.S. Fish and Wildlife Service may establish is outside the scope of this report. However, it is notable that even if the monarch is listed, critical habitat designations can take years to be established and take effect (for example, rusty patched bumble bee was listed in 2017, and no critical habitat has been designated to date).

Company Survey Results: Summary of Assets

In the Company Survey, we asked a series of questions to understand the theoretical opportunity to support monarch conservation, based only on vegetative property being managed by power companies. This was done regardless of property location, current ecological condition, proximity to other habitat or threats, or any other consideration.

We defined *surplus property* as follows: Total **owned** property that is non-operational, meaning NOT a power plant site, solar/wind site, right-of-way, part of a hydro facility, or otherwise currently managed for power generation or delivery.

Based solely on an estimate of total vegetative acres provided by the companies participating in the survey, collective conservation opportunities would be ranked as follows:

1. Transmission Lines: 2,506,887 acres (18 companies reporting)
2. Surplus Property: 424,231 acres (7 companies reporting)
3. Power Plant Sites: 281,103 acres (15 companies reporting)
4. Wind Sites: 178,870 acres (17 companies reporting; dominated by one 103,000-acre site)
5. Substations: 42,512 acres (15 companies reporting)
6. Solar Sites: 10,800 acres (17 companies reporting)
7. Distribution Lines: 485 acres (18 companies reporting)

This ranking is theoretical because it does not consider the realities of, for example, land ownership and control in transmission lines. The low number of solar and wind sites owned by the survey respondents is likely driven by the power purchase agreements that companies hold, which provides renewable power as part of their electricity deliveries from solar and wind sites that they do not own. Notably, most transmission and distribution lines are managed by easements, rather than ownership of the property under the lines. This can limit land management control, as noted later in this report. Although only seven companies in this survey were able to provide a best professional judgment of their surplus property, that asset class already contains a large number of acres and emphasizes an opportunity that EPRI separately identified from experience working with the companies. However, this theoretical analysis now needs to be overlaid with operational, regulatory, and business realities to identify the real opportunities.

Detailed Asset Survey Results

The Company Survey stated, "The following questions request input regarding the land that COULD be planted with a vegetative community to support monarchs. Areas that COULD theoretically be planted include non-concrete areas, open soil, and currently vegetative sites. In responding to these questions, DO NOT consider restrictions such as vegetation maintenance requirements, permit restrictions, or licensing requirements; such barriers will be captured later in the survey."

Note: Companies had concerns estimating only the vegetative portion of their properties in the absence of detailed GIS analysis and/or field site visits. Some companies may have included areas that were concrete and not vegetative land, although they used their best available information (that is, transmission line managers, maps, typical site footprints) to estimate only the vegetative areas. Therefore, these numbers may not represent only vegetative land.

Total vegetative land managed around power plants:

- Total Power Plants: 447 (range: 0–171 plants), all 18 responding. Includes all Hydro, Coal, Natural Gas, Nuclear.
- Note: Two of the responding companies provide electricity delivery only and do not own any power plants.
- Total Acres of all Power Plants: 281,103 acres. 15 responding representing 414 power plants.
- Average Acres per Plant: 656 acres per plant (range: 22–2081 acres). 15 responding representing 414 power plants.

Total vegetative land managed under TRANSMISSION lines (16 responses):

- Total Miles: 160,330 (range: 0–50,200 miles)
- Average Width (feet): 129 ft (range: 67–200 feet)
- Total Acres in Transmission Lines: 2,506,887 acres
- % Transmission Lines OWNED: Responses were typically either 0 (zero) or 100%; one company showed 20% owned
- % Transmission Lines LEASED: All responses were 0 (zero), with two showing 0.5%
- % Transmission Lines managed via EASEMENTS: Range: 80–100%, 12 of 16 reporting entered between 90% and 100%

Total vegetative land managed under DISTRIBUTION lines (18 reporting):

- Total Miles: 704,565
- Average Width (ft): 30 ft
- Total Acres of Distribution Lines: 485 acres
- % Distribution Lines OWNED: <1%

- % Distribution lines LEASED: <1%
- % Distribution lines managed via EASEMENTS: 90–100%

Total vegetative land at substations (15 reporting):

- Total Number of Substations: 12,358
- Average Vegetative Area per Substation: 3.44 acres
- Total vegetative acres of ALL substations: 42,512 acres (based on average vegetative area)

Owned Solar sites (17 reporting):

- Total Owned solar sites: 118 (17 reporting) (range: 0–53)
- Average per company: 6.9 sites
- Total size of ALL solar sites in acres: 10,800 acres (range: 90–9248)
- Average size per solar site: 91.6 acres

Owned Wind farms (17 reporting):

- Total Number of wind farms: 32 (range 0-21)
- Average per company: 1.88 sites
- Total size of ALL wind farms in acres: 178,870 acres (range: 40–103,000)
- Average size per wind farm: 5,590 acres

Surplus Property (7 companies reporting):

- Number of sites/parcels: 128
- Total Acres of ALL surplus sites/parcels: 424,231 (range: 2–264,000)
- Average Size per Parcel: 3392 acres

Case Study: Great River Energy Elk River Prairie Project

In 2016, Great River Energy, the Minnesota Department of Transportation, and the city of Elk River began a project to reestablish 9 acres of native, pollinator-friendly habitat on Great River Energy's Elk River (Figure 4-1). Plugs and seeds were planted in June 2016. Those species planted in the dry prairie included side-oats grama, blue grama, prairie brome, junegrass, little bluestem, prairie dropseed, prairie onion, leadplant, common milkweed, butterfly milkweed, sky-blue aster, partridge pea, prairie coreopsis, white prairie clover, purple prairie clover, stiff sunflower, wild lupine, showy penstemon, long-headed coneflower, prairie cinquefoil, black eyed susan, old field goldenrod, prairie spiderwort, and hoary vervain.

A stormwater retention area was planted with blue-joint grass, slender wheat grass, Virginia wild rye, switchgrass, fowl bluegrass, Indiangrass, prairie cord grass, common fox sedge, green bulrush, woolgrass, marsh milkweed, New England aster, beggar's tick, Joe-Pye weed, sneezeweed, common ox-eye, obedient plant, wild golden glow, and blue vervain.

These plants were specifically chosen for their benefits to monarchs, bees, birds, and other pollinators. Though primarily developed for its environmental benefits, native wildflower plantings are hardy and easy to maintain, and, once established, they require no fertilizing, no irrigation, and only periodic mowing—which greatly reduces maintenance costs. The pollinator habitat saves Great River Energy's member-owner cooperatives approximately $15,000 in annual lawn care costs.

Learn more at www.greatriverenergy.com/elkriverbees.

Figure 4-1
Great River Energy Elk River campus showing the 9-acre prairie planting

5
GENERAL COMPANY SURVEY QUESTIONS

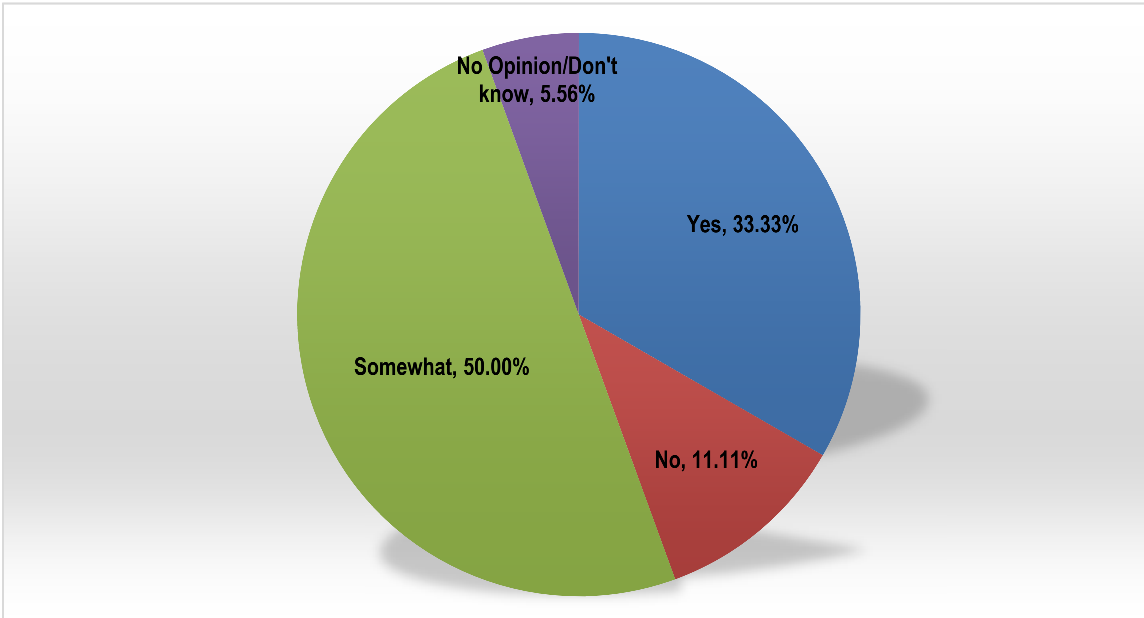
This section presents results of the general questions in the Company Survey.

> *Knowing that the monarch butterfly was being seriously considered to be looked at by the Fish and Wildlife Service to possibly be listed, we decided to verify the milkweed populations on our transmission ROWs to show that there is ample habitat for the monarch based on our approach to utilizing IVM (Integrated Vegetation Management) to manage our ROWs and promote a low-growing plant community.*
>
> Anonymous Company Survey Response

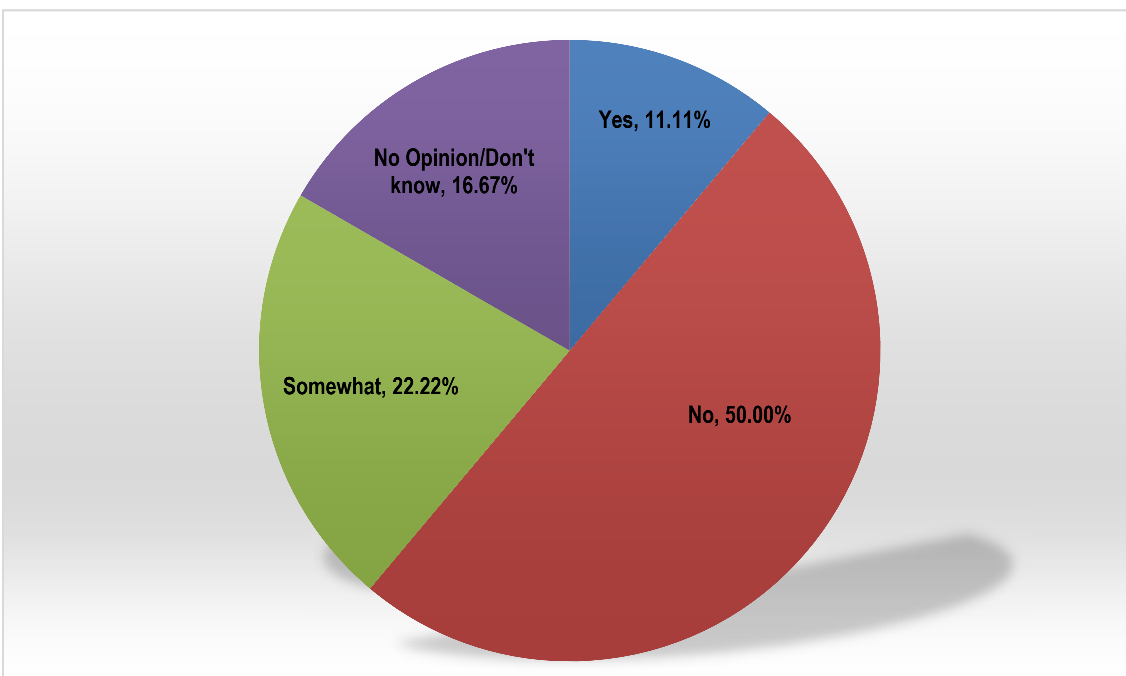
Some discussions between EPRI and companies have suggested that species becoming listed under the ESA can create disincentives for companies to support associated habitat due to resulting legal liabilities and property encumbrances. One survey comment stated, “Financial constraints resulting from lack of regulatory driver or assurances are barriers for us. Why create habitat if we will be creating hurdles for ourselves in the future?” However, our survey results do not reinforce that this concern is broadly shared by the respondents. Survey respondents are more likely to be incentivized to support the monarch with an impending listing decision, with only a few respondents indicating that the possibility of an ESA listing is creating barriers to their proactive conservation actions.

The following two paired questions relate to incentives and barriers to taking conservation actions for the monarch, considering that it could become legally protected in the coming year (2019).

Does the possibility of the monarch becoming legally protected by the Endangered Species Act create INCENTIVES to proactively implementing, reporting, and/or evaluating monarch habitat in your managed areas?

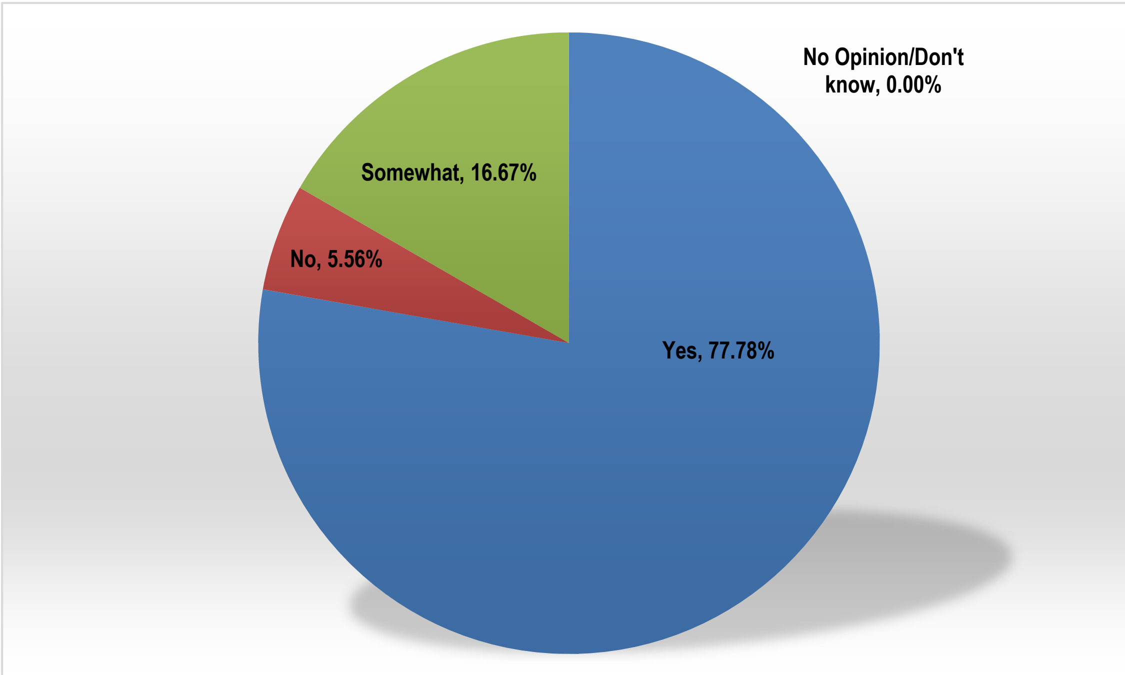


Does the possibility of the monarch becoming legally protected by the Endangered Species Act cause BARRIERS to proactively implementing, reporting, and/or evaluating monarch habitat in your managed areas?

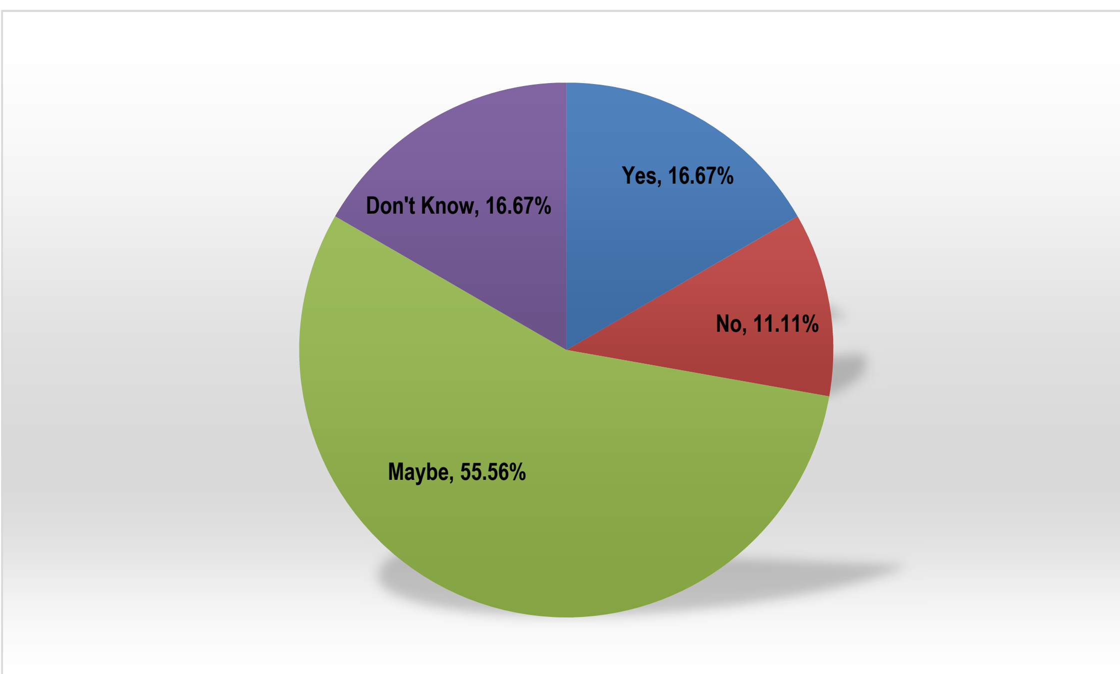


The following are results of the remaining general questions in the Company Survey.

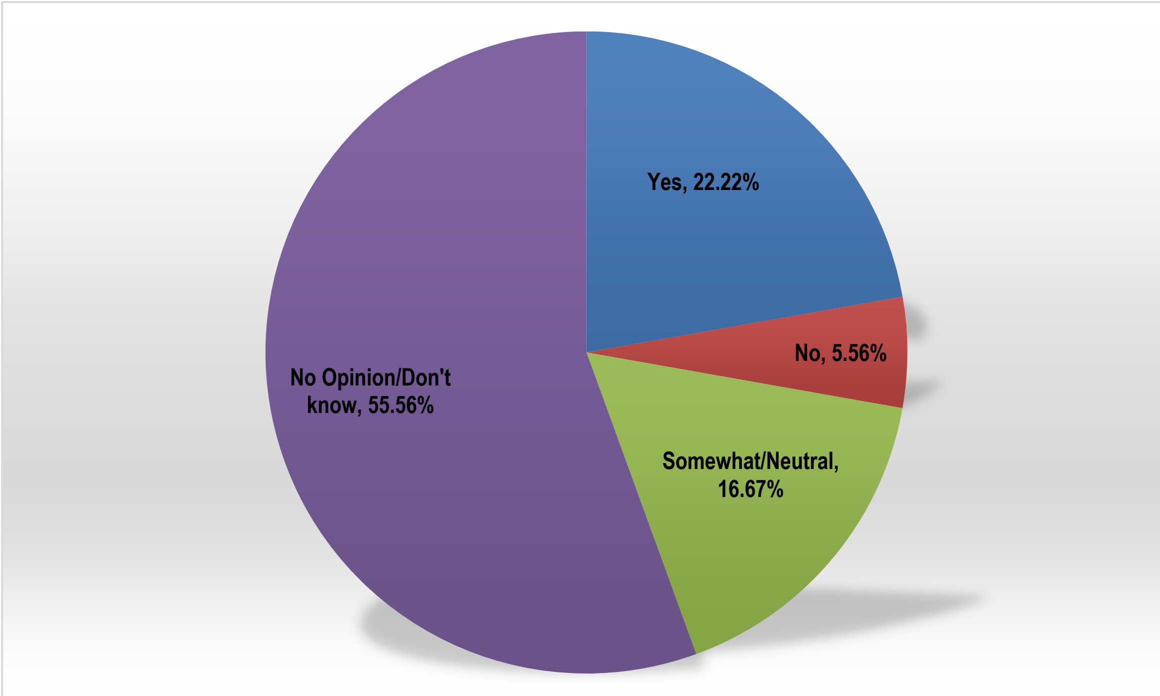
Do you understand the steps that the U.S. Fish and Wildlife Service is using to determine if the monarch is listed?



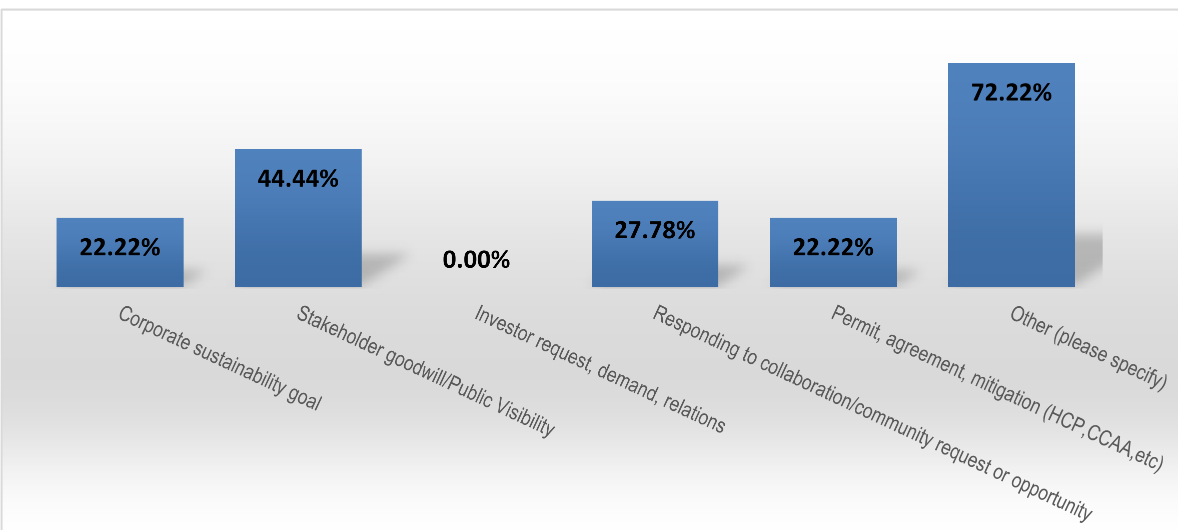
Do you anticipate submitting monarch habitat data to the U.S Fish and Wildlife Service Monarch Conservation Database, which is one data source being referenced to determine the extent to which monarchs need further protection as part of the listing decision?



Are the executives in your company concerned about the possibility of the monarch being federally listed?



What were the primary motivations for your current or past monarch conservation projects? Select all that apply.



"Other" Comments (all shown):

- Interest by employees to use company resources to benefit monarch and pollinators.
- No projects are planned or being implemented specific to monarchs.
- N/A.

- No monarch conservation projects have been implemented.
- N/A - we have no monarch-specific conservation projects at this time.
- N/A.
- Internal natural resource stewardship objective.
- N/A - we have no monarch-specific conservation activities at this time.
- Board member interest.
- Knowing that the monarch butterfly was being seriously considered to be looked at by the Fish and Wildlife Service to possibly be listed, we decided to verify the milkweed populations on our transmission ROWs to show that there is ample habitat for the monarch based on our approach to utilizing IVM to manage our ROWs and promote a low-growing plant community.
- While we have a pollinator program that would benefit monarchs, at this time we have not initiated any activities specifically targeted for monarch conservation.
- N/A.
- Stewardship mission to align with the Natural Resources Plan and T&E program.

6
CONSERVATION ACTIONS FOR MONARCHS

In this section, we present the results of the literature review and Expert Survey (that is, "Scientific and Expert Summary") to summarize the conservation action(s) thought most useful for supporting monarch conservation. Following the Scientific and Expert Summary are the results of the Company Survey for each of the associated conservation actions, as shown in Figure 6-1.

Action (Herbicide Use)

- ❖ Scientific and Expert Summary
  - ➢ Supportive Conservation Actions
- ❖ Company Survey Results
  - ➢ Summary of Extent Implemented, Barriers, Opportunities
  - ➢ Detailed Comments/Barriers

Figure 6-1
Organization of report discussion

The conservation actions included in this report were identified by experts as having the greatest opportunity to minimize threats to monarchs and for power companies to contribute to monarch conservation. Conservation actions for monarchs that are not relevant to most power companies were not included (for example, guidance around insecticide use or managing overwintering sites).

Conservation actions identified next include modifying existing management activities (for example, mowing to maintain ROWs, grazing that is already occurring on the property) to make them more "monarch-friendly" as well as new actions to consider adopting to benefit monarchs (for example, monitoring for milkweed, restoring monarch habitat).

Primarily, power companies can aim to identify, protect, and manage *existing* monarch habitat through appropriate timing and application of land management techniques.

Secondarily, efforts can be made to enhance, create, or restore habitat where appropriate. Native, blooming shrub and wildflower plantings—including milkweed—which support pollinators and monarchs, can be an integral component of conservation efforts and, ideally, part of larger ecosystem protection efforts.

Here we provide a range of supportive conservation actions that can be adopted to help monarchs where power companies have the opportunity; consider adopting the conservation practices that are regionally appropriate to your land assets. In some circumstances, there may be trade-offs (short-term impacts vs. long-term benefits) of specific practices to monarchs and their habitat. In these cases, we recommend leaving areas of refugia and using methods to minimize short-term impacts to the species while still considering the long-term conservation benefits.

General Vegetation and Timing Management

Use strategies to prevent establishment and/or spread of invasive plants and undesirable woody vegetation encroachment, including making site- and plant-specific determinations regarding the need for and level of intervention; considering a combination of management techniques (biological, physical, chemical, and cultural practices); and ensuring treatments are completed in a manner that minimizes risks to non-target organisms and the environment and addresses concerns of the landowners. On applicable asset types, develop and implement an IVM plan.

Understanding when monarchs are present and breeding in a region allows land managers to avoid using management practices such as mowing or burning during times when monarch immature stages (eggs, larvae, pupae) are present. Based on the best available data for when and where monarchs breed, Xerces and Monarch Joint Venture 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. Data used are breeding data and adult records from the Monarch Larva Monitoring Project, Journey North, and the Western Monarch Milkweed Mapper as well as expert opinion by field biologists and scientists. In the West, management windows were customized by EPA Level III ecoregion; in the East, they are separated by latitude with ecoregions visible. We are still learning about the phenology of monarch breeding—when the earliest breeding begins and the latest breeding ends—in different regions of the West. As such, these management windows should be viewed as approximate recommendations.

The exact timing of monarch breeding may vary from year to year and site to site—and these windows may be revised in the future as we learn more. This is especially true for areas where little data are currently available on the timing of monarch breeding, such as the states that straddle the continental divide. Also, as long as milkweed is present in the landscape during the breeding season, there is a chance that monarchs are also there and that management actions could result in direct monarch mortality. Because every year and site are slightly different, it is useful, while difficult, to survey milkweed plants for immature stages of monarchs prior to mowing, burning, grazing, or using herbicides. This 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. In some circumstances, there may be trade-offs (short-term impacts vs. long-term species benefits) of vegetation management of monarch habitat during the breeding season (for example, to control invasive plants). In these cases, we recommend spot-applying management techniques to avoid milkweed plants when possible or try to leave at least some milkweed unaffected to act as a refugia.

Generally, milkweeds are easy to identify, and training staff or volunteers to recognize milkweed and avoid mowing, spraying herbicides, or otherwise disturbing plants during the breeding season can be an effective solution.

Regional management windows for monarchs can help guide timing of management activities. Management activities are least likely to have negative effects on monarchs during windows when monarchs are not typically breeding. Figure 6-2 is adapted from the Monarch Joint Venture handout "Mowing for Monarchs," but these timing windows are relevant to other vegetation management practices as well, including grazing, prescribed burning, and more.

These management windows are based on the biology of monarch butterflies and regrowth of milkweed. They may conflict with other priorities of power companies. Applications of certain herbicides may be most effective if applied outside the management window, for example, or mowing times that are best for monarchs may be less desirable for other at-risk species. It can be difficult to balance the needs of many species, and all actions should be context-based with consideration of the specific sites and ecological conditions. Here we provide recommendations on the timing of management as pertains to monarch butterflies, recognizing that power companies will need to adapt these recommendations for their own situations as they consider other factors.

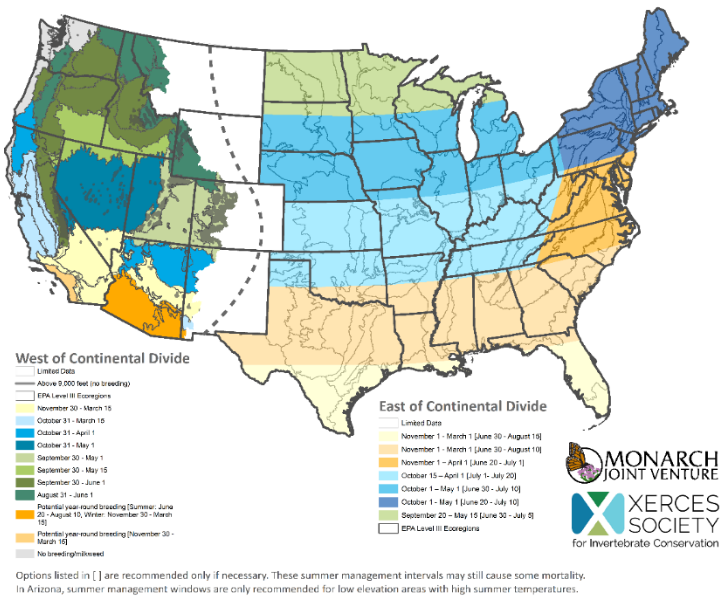


Figure 6-2
Regional management window for monarchs

Herbicides

Scientific and Expert Summary: Herbicides

Herbicides account for the vast majority of electric utility pesticide use—primarily to remove tree and shrub species from rights-of-way. Herbicides used to control encroaching woody vegetation and invasive species on transmission and distribution rights-of-way can, like other control techniques for undesirable plants, benefit butterflies (Bramble et al., 1997, 1999; Wagner et al., 2014a) and other pollinators (Wagner et al., 2014b; Russell et al., 2018), and may support monarchs by suppressing undesirable plants that displace nectar plants and milkweeds.

However, widescale use of broad spectrum herbicides can reduce the value of habitat to monarchs by removing floral resources and host plants. For example, the rise of herbicide-resistant row crops in particular has been linked to large-scale declines in milkweeds in the United States east of the Rocky Mountains, with negative impacts on the eastern monarch population (Pleasants and Oberhauser, 2013; Flockhart et al., 2014; Stenoien et al., 2018; Saunders et al., 2017; Thogmartin et al., 2017b; Zaya et al., 2017). A recent study (Crone et al., in review) pointed to land use changes, including the increase in herbicide use, as potentially one of the primary drivers of the western monarch population’s decline. Overuse of broad spectrum herbicides can also weaken stands of vegetation, increasing invasive species encroachment and furthering degradation of habitat for monarchs and other wildlife. Herbicide practices that contribute to the large-scale loss of milkweed and important nectar resources should be avoided.

The indirect effects of herbicide use that reduces or eliminates milkweeds and nectar plants are more likely to have adverse impacts on monarchs than direct toxicity. Few studies have measured direct toxicity of herbicides to butterflies, and none has evaluated toxicity to monarchs. Although herbicides are designed to kill plants and do not target insects, studies indicate that some may be toxic to butterflies, causing sublethal effects. Butterflies can be exposed to herbicides through direct contact, contact with herbicide residuals, and caterpillar ingestion of treated host plants. Effects of herbicide toxicity to butterflies can range from reduced caterpillar and pupal mass (Bohnenblust et al., 2013), reduced development time, pupal weight, and wing size (Russell and Schultz, 2010), to reduced survival (Russell and Schultz, 2010; Stark et al., 2012; Schultz et al., 2016). Alterations in development induced by herbicides can have population-level impacts (Russell and Schultz, 2010), and herbicide exposure that reduces caterpillar or pupal survivorship can reduce populations over time (Stark et al., 2012).

Toxicity of herbicides to butterflies varies with the chemical, its formulation, and the organism and its life stage (Brown, 1987; Kutlesa and Caveney, 2001; Russell and Schultz, 2010; LaBar and Schultz, 2012). How one species responds may not predict the response of another. Although there are unknowns about the potential toxicity of herbicides to monarchs, best practices include reducing herbicide exposure to monarchs whenever possible. Employ a variety of techniques to manage undesirable vegetation, including cultural and mechanical control. When herbicides are used, avoid direct application to milkweed plants, and make applications when caterpillars are not present whenever possible (see Figure 6-2). Effects of tank mixes of herbicides on monarchs or other pollinators are unknown. The effects of inert ingredients in formulated products on monarchs are also unknown. Land managers can reduce herbicide use and subsequent impacts of herbicides on monarchs by implementing a vegetation management plan, including IVM, which incorporates monarch-specific best management practices outlined next. These practices can be adapted by power companies to fit their regional context or overall management goals. For example, it may not be a priority for power companies to control herbaceous invasive weeds on rights-of-way because such vegetation does not impact transmission, but we include herbaceous weed control as a recommendation to consider because controlling herbaceous invasive species can improve monarch habitat. By controlling invasive species or woody plants that shade out monarch habitat, managing habitat with herbicides may have long-term benefits that outweigh negative impacts to monarchs present at the site in the short term.

- ***The majority of experts surveyed said it is beneficial to protect existing monarch habitat from broadcast, broad spectrum, non-targeted herbicide spraying.***

Supportive Herbicide Conservation Actions

General Actions

- Use herbicides within a vegetation management plan that incorporates the following principles:
  - Prevent conditions that allow incompatible plants or invasive plant populations to survive and reproduce.
  - Evaluate the range of management techniques (for example, chemical, physical, and mechanical) to select the least harmful, most effective, feasible vegetation management method.
  - Select and apply herbicides to minimize risks to non-target organisms such as monarchs.

- Recognize the plants or weeds that need controlling and know how to distinguish them from similar non-target species.

  If needed, train staff and contractors in plant identification. The ability to recognize native plants (for example, tall thistle, *Cirsium altissimum*, an important fall-blooming nectar plant for migrating monarchs) as well as invasive weeds (for example, Canada thistle, *Cirsium arvense*) will reduce unintended damage to non-target plants.

- Whenever possible, prevent conditions that would allow incompatible vegetation or invasive species to establish or reestablish.
  - Control woody plants that re-sprout or sucker to stop regrowth and encourage desirable early successional vegetation.
  - Wash all equipment prior to accessing a new site to avoid transferring weed seeds between sites.
  - Monitor vegetation regularly to stay on top of emerging non-compatible vegetation issues.
- If necessary (for example, if the seed bank was depleted of desirable species), replant areas of dense infestations of undesirable vegetation following herbicide treatments with desirable, competitive, low-growing plant species to reduce the need to re-treat the area.

Product Selection

- When available, use selective herbicides targeted to the plants in need of control. For example, when appropriate, the use of tree growth regulators is preferred vs. the broadcast use of a broadleaf herbicide, which would remove nectar and host plants.
- Apply herbicides at the lowest effective application rate specified on the product label.

Timing of Application

- Apply during plant life stages when target plants or weeds are most vulnerable.
  - Treat plants before bloom or before they set seed; this will reduce the weed seed bank. If weeds are treated after seed set, their populations will persist in future years despite herbicide treatments.
- Time broadcast herbicide applications to avoid monarch exposure.
  - If possible, avoid broadcast applications during monarch breeding and migration season (for example, make applications in early spring or late fall; see Figure 3-2 [management windows] for details for your region).
  - Make applications of broad spectrum products when milkweeds are dormant.

Method of Application

- Use the most specifically targeted application method that can effectively meet your vegetation management goals. Keeping applications directed on undesirable vegetation will avoid weakening non-target species.

  - Selectively control undesirable plants with spot treatments, frill treatment, weed wipe, or other well-targeted techniques.
  - Target non-compatible vegetation using spot treatment applications made with a backpack sprayer, weed wiper, or similar appropriate technology.
  - Use highly targeted applications to cut stems, stumps, or under bark.
  - Broadcast foliar treatments should be used only for dense infestations of incompatible vegetation or invasive plants.
- Take precautions to avoid off-site movement and reduce the risk of drift.
  - Carefully choose and calibrate your spray nozzles.
  - Conduct applications on calm days when wind speed is between 2 and 8 miles per hour (mph) (avoid applications during gusty or sustained high winds).
  - Avoid application during a temperature inversion and when conditions are likely to cause evaporation. No wind suggests that there is possibly an inversion present.
  - On boom sprayers, use the lowest effective pressure and largest droplet size possible. Set nozzles low so they operate just above plant height.
  - Use drift control agents as necessary.
- When selecting the most appropriate application method, consider the off-site movement risk of aerial and most blowers. If possible, avoid their use. When aerial applications cannot be avoided, take precautions to limit drift.
  - If safe, fly at the lowest height and speeds possible.
  - Use large droplets and low pressure.
  - Perform applications under proper weather conditions.
- If using broadcast applications of broad spectrum products, include a non-sprayed buffer around key areas of monarch habitat, including overwintering sites.
- Hire contractors trained in plant identification and habitat protection methods. Create specifications that would hold contractors accountable.

Company Survey Results: Herbicides

Extent Implemented: *Moderate*
Barriers: *Moderate*
Opportunity: *Moderate*

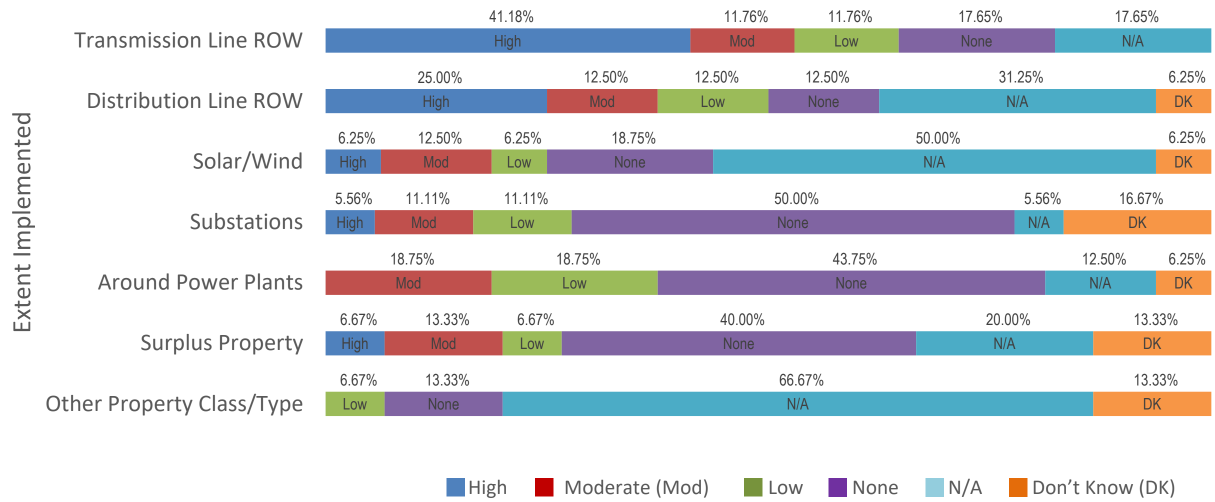
Overall, there is relatively high adoption for the herbicide-related conservation activities included in this survey. The avoidance of drift and off-site movement of herbicides was high across land types. The avoidance of aerial application of herbicides was also reported as relatively high as well as the use of herbicides at the lowest effective rate. However, there was notable reporting of “N/A” and/or “none” for several property types, indicating future potential for more extensive adoption of the specified herbicide-related actions. Specific to transmission systems, most are on a management rotation cycle with herbicides being applied once every 3–5 years on specific line segments.

General Comments/Barriers to Herbicide-Related Practices

Comments from survey respondents point to the alignment of the activities with their current practices on certain property types:

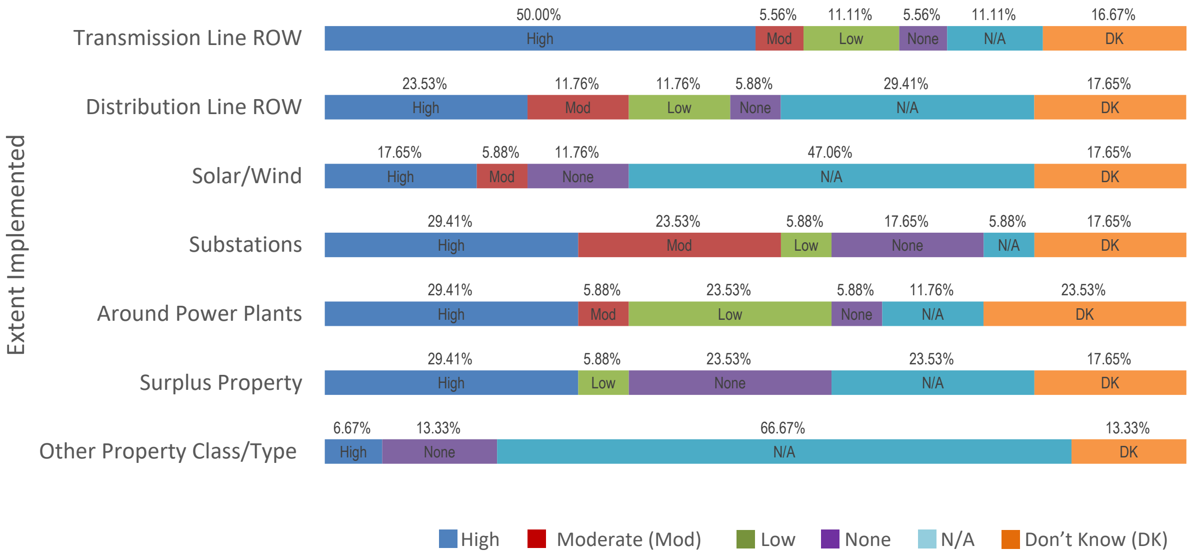
- Our IVM plan includes selective herbicide spray applications to manage trees/woody species that could grow tall and affect our transmission lines.
- Only 1/3 of our transmission line service area is managed a year, and we use only the minimum amount of pesticide per acre.
- The substation program currently aims to reduce the use of herbicides but has not eliminated the need.
- We mow ROWs every few years and around the plants/substations only as needed to meet access and maintenance requirements.
- Wherever herbicides are used, the lowest effective application rate is applied.
- There may not be much awareness regarding the timing of herbicide treatments to minimize impacts to pollinators unless there is an agreement in place with USFWS because of the presence of a listed plant or pollinator species.
- For transmission line ROWs, the barriers are landowner concerns. For substations, there are not a lot of staffing resources available to pull weeds.
- No internal program developed to specifically target species known to harm monarch habitat.
- Need best practice guidance for selecting herbicide with minimal non-target species impact.
- Some selective herbicides are currently used; however, specific processes to target invasive plants are not in place.
- Barrier is that herbicide application is managed by our contractors and/or partners.
- Our property maintenance is largely done based on a pre-planned schedule, not responsive to vegetation blooming or specific species selections (that is, milkweed).
- Solar sites are managed by other project partners, not our organization.
- Barriers are staff training and education, including contractors.

Herbicides: Use herbicides within an integrated vegetation management (IVM) plan that specifically minimizes impacts to pollinators, includes selecting the most effective and feasible invasive plant management method (for example, physical, mechanical, chemical).



- We do not operate within an IVM plan.
- No formal IVM plan for pollinators; training and cost-benefit analysis needed. However, I don't believe herbicides are used, except maybe on the main campus.
- No management plan in place. Time and resources limited.

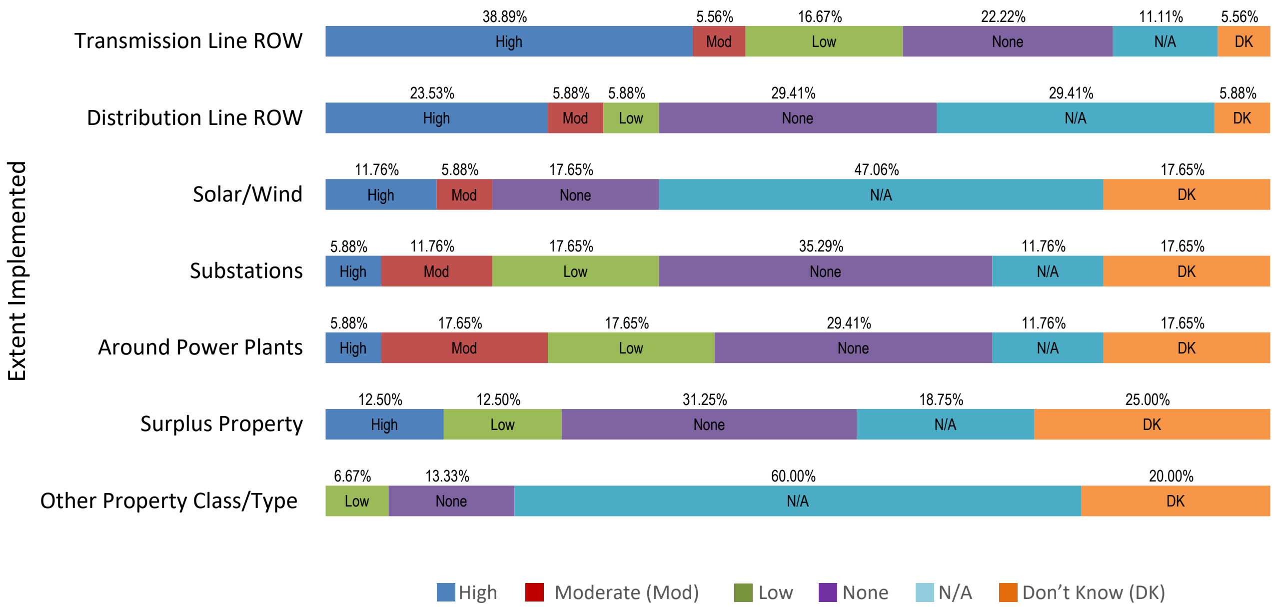
Herbicides: Apply herbicides at the lowest effective application rate specified on the product label.



Detailed Comments/Barriers

- Must use rate to get control of incompatible species in one season due to working on a cycle for maintenance.
- Education of applicators, contractors, and staff can be barriers.
- Contractors appropriately follow suggested spray rates on SDS sheets.

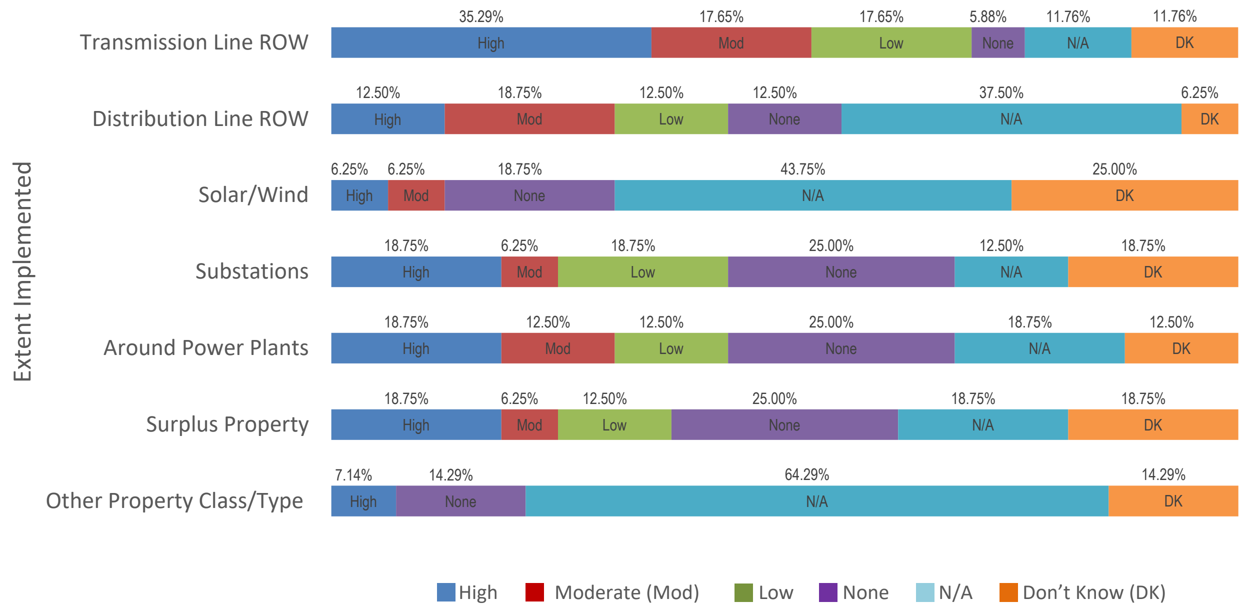
Herbicides: Use selective herbicides to reduce damage to non-target plants and avoid impacts to monarch-supporting vegetation.



Detailed Comments/Barriers

- For transmission line ROWs, we do not treat non-target plants.
- We apply a mix of selective and non-selective herbicides in a targeted program.
- Broadleaf or general herbicides used at substations. Majority of other applications use broadleaf specific herbicides.
- Selective herbicide applications are currently used; however, specific processes to avoid damage to non-target plants are not in place. Barriers include costs, because specifically targeting certain vegetation precludes the use of aerial and high-volume applications, requiring a change to more expensive low-volume and basal stem applications. This leads to human safety problems, because low-volume (backpack) applications translate to walking the ROWs. Rough terrain in numerous areas introduces increased opportunities for slip/trip/falls, insect/snake bites, sprains/strains, and so on.
- This rarely applies to Surplus Properties but will use selective herbicides if needed.
- Starting to do more selective application as part of regular maintenance on other properties.

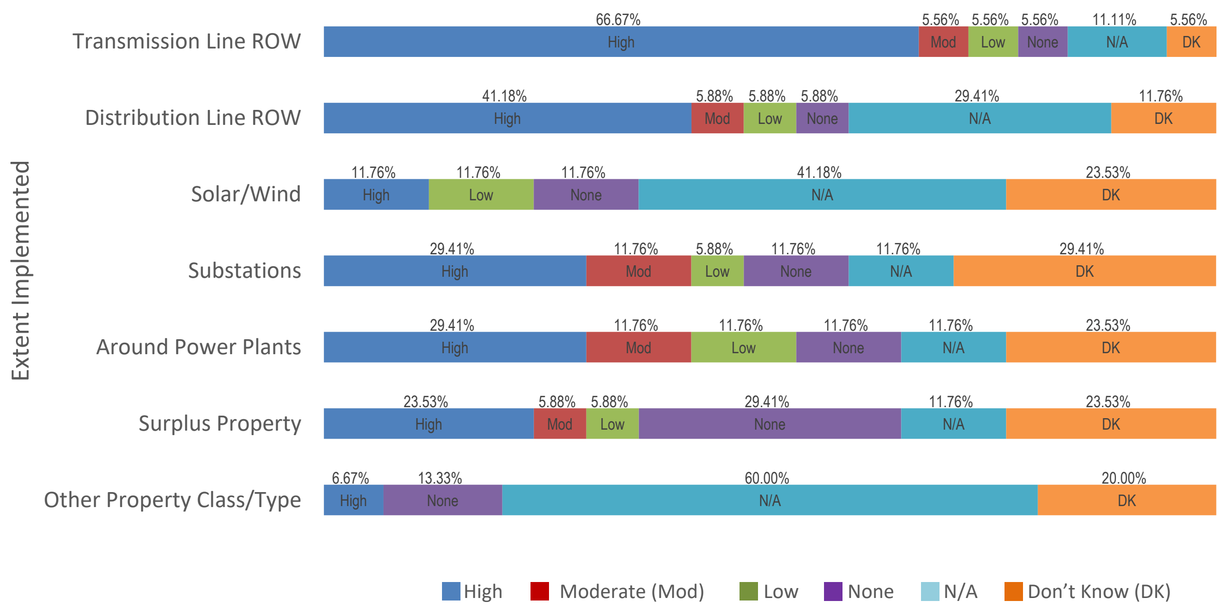
Herbicides: Apply herbicides during plant life stages when target plants are most vulnerable (before blooming or going to seed).



Detailed Comments/Barriers

- For transmission line ROWs, we may receive notification that there are occurrences of noxious weeds that need to be treated while they are in bloom or after they bloom. They may be treated after notification and not be in their most vulnerable state.
- We don't target the species based on plant life cycle. Rather it's based on when the area is scheduled to be managed.
- Difficult to spray in spring when it's raining and weeds are emerging. Contractor availability and amount of land to cover makes it difficult to fine-tune treatment timing.
- This is likely not an option due to herbicide application contracts.
- Reduces the application window (leaf out to leaf drop) and makes site scheduling very complex. Costs are potentially higher, because return trips to locations that were skipped due to timing would be required.
- Timeframe of maintenance work and scale of work drive treatment timing.

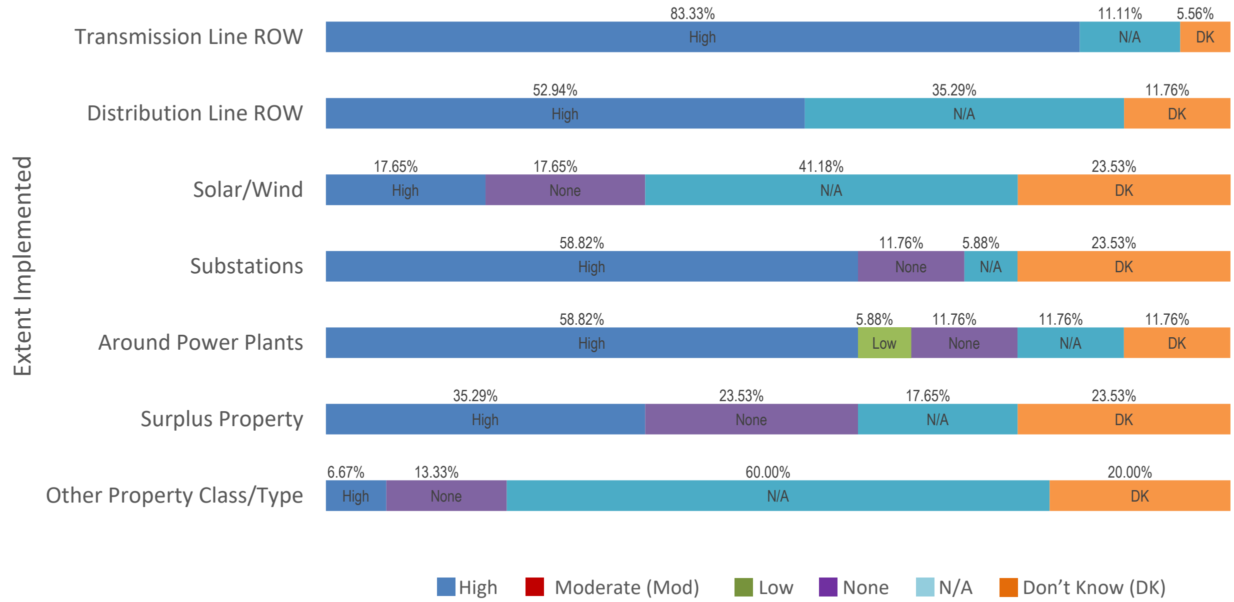
Herbicides: Keep herbicide applications directed on target plants to avoid weakening non-target species such as targeting species using spot treatments (for example, using backpack sprayer, weed wiper, or directly onto cut stumps/under bark).



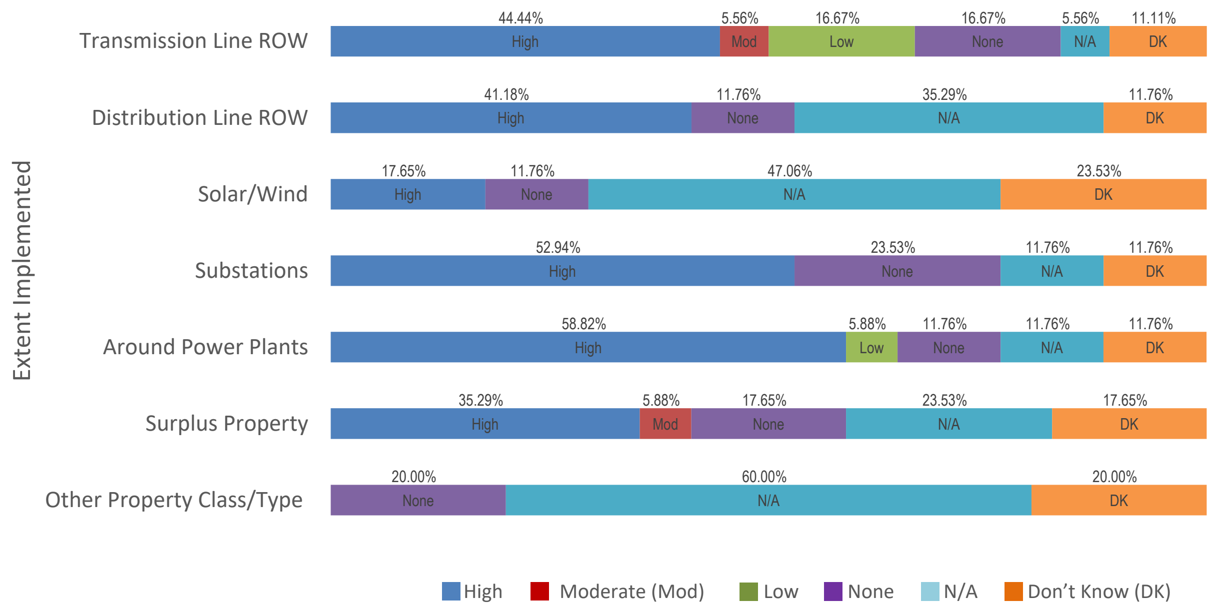
Detailed Comments/Barriers

- Already implemented for targeted species that are woody/tall growing.
- Our contractors exclusively apply herbicides via low-volume backpack sprayer on selective target species or cut stump treatment.
- Majority of treatment company-wide are spot treatments.
- Stump/cut stubble treatments are currently used when removing trees and mowing.
- Rarely apply to Surplus Property but will apply to targeted plants only, if needed.

Herbicides: Take precautions to avoid off-site movement of herbicides and reduce the risk of drift such as avoiding applications when wind speeds are over 15 mph or during temperature inversions, keeping equipment calibrated, and using the lowest effective pressure and largest droplet size possible.



Herbicides: Do not use aerial application of herbicides.



Detailed Comments/Barriers

- For transmission line ROWS, aerial application is used only where there is restricted or no entry allowed on the ground for some reason, such as with some hazardous material sites.
- For substations, aerial application would not be feasible. It is likely that there are not enough vegetated acres at substations to make it economically worthwhile.
- No aerial applications occur in our service area.
- We do not apply herbicide via aerial means, unless specified for *Phragmites* removal projects.
- Aerial application not used.
- Aerial applications on transmission ROWs will continue until a credible business case can be made to substitute the practice with an alternative herbicide application method.
- Approximately 2% of our transmission ROWs are managed via aerial herbicide application. These areas are associated with remote access and difficult terrain.
- Aerial application is the best application for certain areas with poor accessibility, used seldom but does get used on a rotation of years.
- Barriers include costs and human safety. Targeting invasives precludes the use of aerial and high-volume application, requiring a change to more expensive low-volume and basal stem applications. Low-volume (backpack) application translates to walking the ROW and introduction of safety issues in areas of rough terrain and risk of slip/trip/fall, insect/snake bites, sprains/strains, and so on.

Case Study: Ameren Transmission Lines for Pollinators and Monarchs

In 2016, Ameren Transmission began what eventually became an ambitious pollinator project involving multiple collaborating partners. Ameren has easement rights on Exelon-owned property in the Clinton, IL area. Two 345-kV transmission corridors that run parallel to each other had patches of incompatible vegetation between them that were declining and needed frequent maintenance. As part of this project, the trees were removed and the area was mowed. The question arose as to whether these areas should be seeded, and if so, with what type of seed mix. Because Ameren was in the process of developing a formal partnership with Pheasants Forever to promote pollinator habitat, this became the pilot project. Working together over the following year, Ameren, Pheasants Forever, Exelon, Van Horn Inc, the U.S. Fish and Wildlife Service (FWS), and the Illinois Department of Natural Resources (DNR) cleared, mowed, sprayed, and seeded 65 acres of transmission right-of-way with a high-quality pollinator seed mix (see Figure 6-3). In addition, a community outreach event was held in which 200 second- and fourth-grade schoolchildren learned about pollinators, plants, electricity, and water conservancy and made seed balls to be distributed into the right-of-way. Eighteen months later, milkweed is flourishing, nectar plants are blooming, and what was previously a high maintenance area of declining trees is now well on its way to becoming a much lower maintenance pollinator habitat (see Figure 6-4). This successful venture was the flagship of several projects that followed and the one that had the most participating partnerships.

Figure 6-3
Before planting (left) and after planting with native forbs and grasses (right)

Figure 6-4
Milkweeds that established in ROW and are supporting monarch caterpillars in Clinton, IL

Invasive Species Management

Scientific and Expert Summary: Invasive Species Management

Invasive species, including those designated as noxious weeds, are species that outcompete and suppress desirable vegetation; pose a serious threat to ecosystems; and can significantly alter plant community composition, ecosystem processes, soil chemistry, and water filtration and increase fire intensity and frequency (DiTomaso, 2000; Duncan et al., 2004). Invasive plants are most often introduced nonnative species that lack natural enemies within their new range and possess certain traits that allow them to be highly adaptable and successful invaders, but native species can also become invasive (for example, Eastern red cedar invades and degrades prairies and other open grasslands that support monarchs). Studies assessing the effects of invasive plant management on monarchs or monarch habitat are limited; however, the effects of invasive plant removal on other pollinators have been summarized in several synthesis studies from various regions of North America and Europe (Goodell, 2008; Bartomeus, et al., 2008; Stout and Morales, 2009; Morales and Traveset, 2009; Roulston and Goodell, 2011; Fiedler et al., 2011; Hanula and Horn, 2011; Montero-Castaño and Vilà, 2012; Bezemer et al., 2014; Litt et al., 2014; Tonietto and Larkin, 2017). These studies suggest that pollinators generally are affected negatively by an invasive plant if it alters the abundance of native floral resources, and this effect is often species- or taxa-specific (Roubik and Villanueva-Gutiérrez, 2009; Cane, 2011; Roulston and Goodell, 2011). Research also suggests that native bees, butterflies, and other insects prefer to feed on native rather than invasive nonnative plants (Williams et al., 2011; Hopwood, 2008; Burghardt et al., 2009; Wu et al., 2009; Morandin and Kremen, 2013) and that native plants support a greater diversity of Lepidoptera species compared to nonnative plants (Tallamy and Shropshire, 2009). It is unknown whether monarchs prefer native over nonnative nectar resources, but the species tends to be a generalist, feeding on a wide variety of plants in many different botanical families (Xerces Society, unpublished). Although invasive plant removal improves habitat for pollinators in the long term, removal of flowering invasive plants has been suggested as a cause of decline for some pollinator populations by reducing available floral resources (Tepedino et al., 2008; Severns and Moldenke, 2010; Bezemer et al., 2014; Harmon-Threatt and Chin, 2016).

Controlling or removing invasive plants is particularly a balancing act for land managers working in degraded landscapes where native nectar sources for monarchs may be scarce. In some landscapes, invasive plants such as thistles may be the only species available as forage for monarchs. This is especially apparent in degraded landscapes of the western United States where invasive thistles (for example, musk thistle, *Carduus nutans*) provide nectar in the summer months when other floral resources are scarce. Removal of invasive plants under these circumstances may reduce nectar availability for monarchs and other pollinators—but control of invasive plants is generally more important than the floral resources they provide. To minimize these negative, short-term impacts, a plan should be in place to plant commensurate native floral resources immediately after large-scale removal of invasive plants known to provide exclusive nectar resources for monarchs and other pollinators.

Invasive plants are often found and spread along roadsides and other rights-of-ways—where milkweed species commonly grow and support monarch breeding. Invasive plants in these linear habitats are commonly managed with mowing and herbicide applications during times when milkweed is actively growing and monarchs are present. These management practices have the potential to kill milkweed plants and immature monarchs but are also important to reduce the spread of invasive plants. See the Management Timing section of this report for more guidance.

Invasive species management can have positive effects on native bees and butterflies (Hanula and Horn, 2011; Baskett et al., 2011; Fiedler et al., 2012; Tonietto and Larkin, 2017; Goodell and Parker, 2017). A meta-analysis by Tonietto and Larkin (2017) investigated the overall effects of restoration treatments, including invasive plant removal, on native bees. The analysis found that of all restoration treatments, invasive plant removal had the greatest positive effect on the diversity and abundance of native bees. One study included in the meta-analysis (Hanula and Horn, 2011), demonstrates the significant benefits. They found that the removal of Chinese privet (*Ligustrum sinense*)—an invasive shrub—greatly improved habitat for butterflies and bees in riparian forest in the southeastern United States: five years after shrub removal, treatment plots had three times as many bees and butterflies compared to control plots.

Overall, controlling invasive plants with a goal of maintaining or conserving healthy, native plant communities is desirable at an ecosystem level, but care should be taken in the short term to ensure phased removal and replacement with alternative resources for monarchs.

- ***The majority of experts surveyed agreed that it is beneficial to control invasive herbaceous plants that are not known to be nectar sources for monarchs; however, it is complicated to control invasive herbaceous plants that are known to be nectar sources for monarchs.***

Supportive Invasive Species Conservation Actions

- Use Early Detection Rapid Response (EDRR) for new invasive plant occurrences. Learn more about this approach on the Invasive.org website.
- Prioritize control of invasive plants in habitats with existing milkweed or areas with high native plant diversity and abundance and resiliency to invasion. Distance from native plant communities is inversely related to native-pollinator abundance and diversity.
- Ensure that revegetation plans are in place. Before or directly following invasive plant removal on a large scale, ensure that there will be similar native floral resources available for monarchs and other pollinators.
  - Native perennial plants can deter recolonization of invasive plants. Choose persistent native species suitable for the conditions of the site, and consider starting with container plants rather than seed to give native species a competitive advantage over weeds.
  - Replace with native perennial monarch nectar or host plants with similar phenology as the invasive species targeted for removal.
  - If the invasive plant is providing nectar during a time of scarce floral resources (for example, fall migration), removal can have negative impacts on monarchs and other native pollinators. Consider a phased removal and revegetation plan to avoid removing major floral resources. This could include high-quality habitat restoration or, for more temporary habitat, the use of an inexpensive nonnative species such as red clover or alfalfa to create monarch “pastures.”
  - See the Restoration and Revegetation section of this report for more information.

- Minimize invasive plant spread by limiting vectors. There are many vectors for invasive plant spread, including wind, water, recreation (on boots, bike tires, off-highway vehicle [OHV] tires, horses, mules, and so on), livestock (on hooves, hair), livestock feed (hay), roads, cars, and heavy equipment such as tractors, mowers, and brushers. The spread of invasive plants can increase in response to disturbances such as fire, recreation, roads, fuels reduction, forest thinning, logging, restoration, floods, and grazing.
- Minimize soil disturbance (disking, tilling) during management activities to avoid spreading invasive plants.

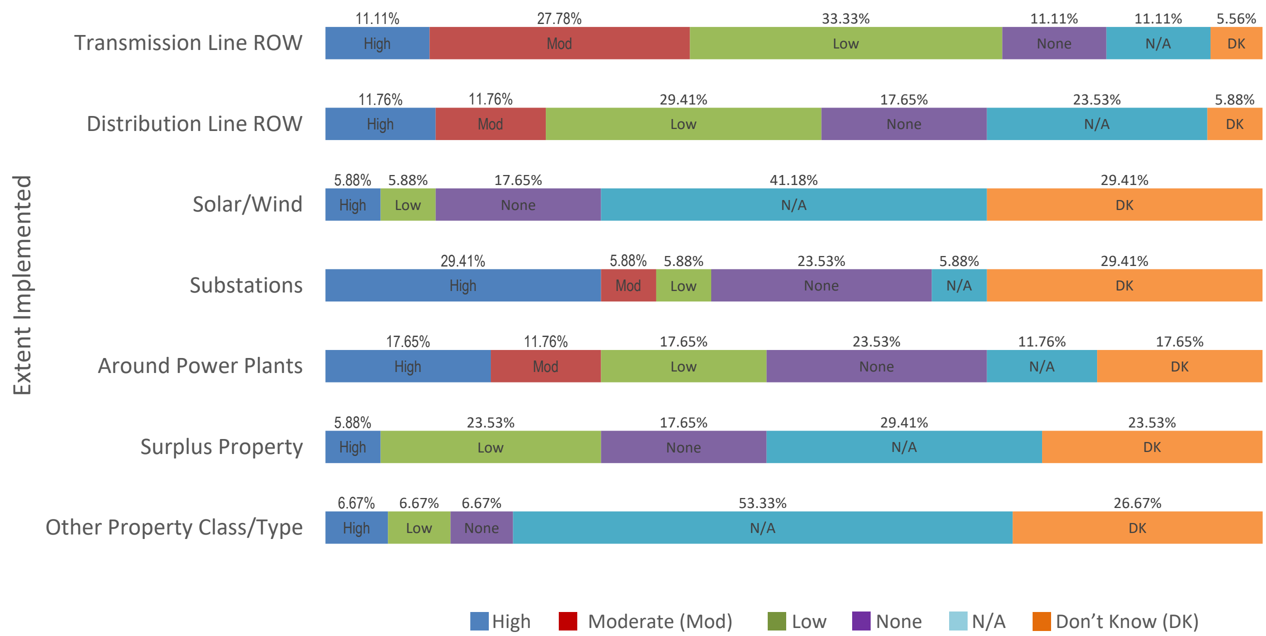
Company Survey Results: Invasive Species

Extent Implemented:	*Low-moderate*
Barriers:	*Moderate-high*
Opportunity:	*Moderate-high*

General Comments/Barriers to Invasive Species and Brush Management Practices

- Barriers include budget, staff education, and information.
- Barriers include training—would need to train vegetation management crews to target specific species.
- Work plan changes—would limit aerial spray and high-volume foliar application of herbicide; higher costs—achieving this would mean move to low-volume (backpack) herbicide application, which is more costly than aerial and high-volume applications; safety—accessing lines and walking the ROW (especially in the mountains) is hazardous pertaining to slips/trips/falls.
- Budget constraints.
- No regulatory driver for actions described.
- Cost and having knowledgeable contractors to identify plants are barriers. We contract out our vegetation management.
- Training on benefits and identification would be needed to implement change.
- We have a set schedule for vegetation control, and this work must be done on that pre-determined schedule.
- We don’t do any focused invasive species management.
- No active removal of invasive plants occurs within our service areas. Our goals are to generally leave the vegetation alone and remove only what causes concern (woody/tall species).
- Easements cannot prohibit landowner activity, so we may not have control over actions in our transmission lines.

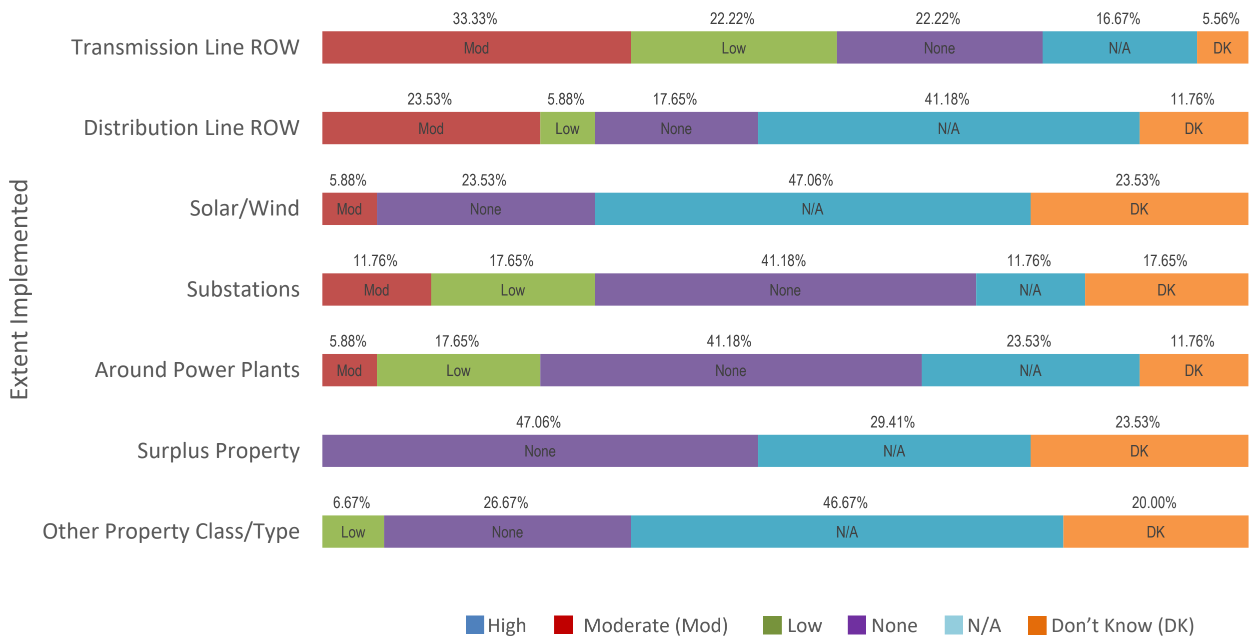
Manage Invasive Species: Control herbaceous invasive plants in addition to woody invasive species.



Detailed Comments/Barriers

- On transmission line ROWs, control of herbaceous invasive plants is limited to noxious weeds that are mandated to be controlled at that location.
- Barriers are funding levels that may limit the amount of area where we have the resources to actively control noxious weeds.
- At substations: outside the substation fence, funding levels may limit the amount of area where we have the resources to actively control noxious weeds.
- Within the substation fence, all vegetation is removed from the substation yard because there is a bare ground contract that controls all vegetation within substations.
- Our IVM plan does not discern invasive vs. native plants, only growth types such as woody or tall trees that may interfere with our overhead lines.
- Invasive species management occurs on transmission and distribution lines on federal lands and at plant/hydro sites where required under licenses/management plans. Herbaceous weeds at substations are currently controlled but not eradicated, depending on service level.
- Probably not done enough due to rotation schedule, which determines management cycle.
- Portions of the transmission and distribution ROWs are maintained using low-volume herbicide applications.
- Control invasives when causing reliability or access issues; cannot control all sites and lines due to cost and noxious status.

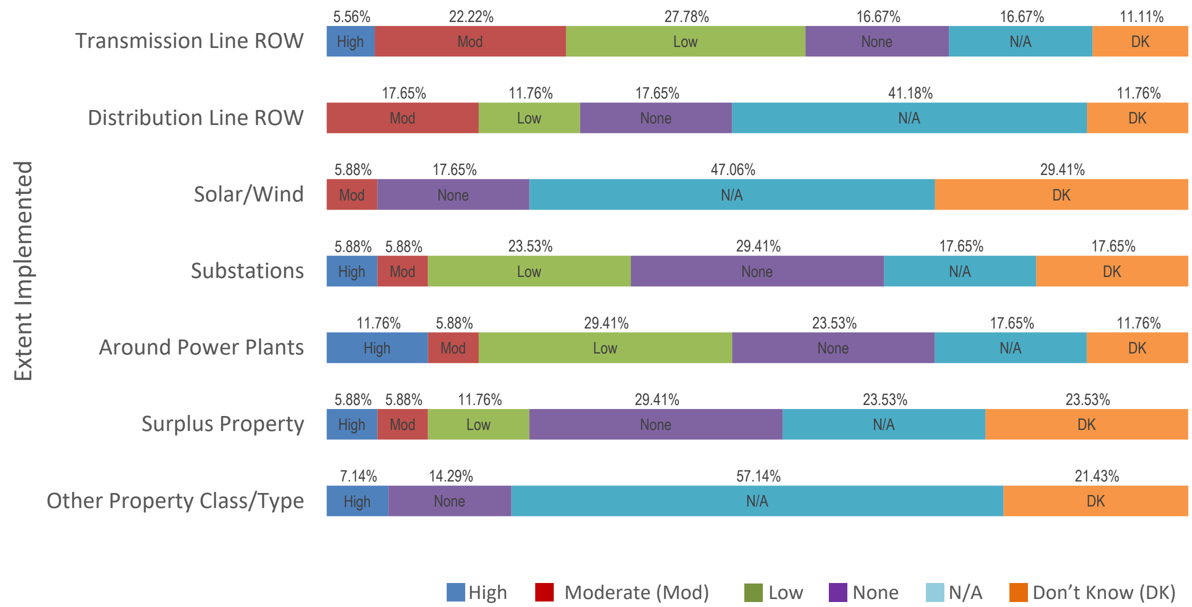
Manage Invasive Species: Clean mowing equipment after use and between sites to limit the spread of invasive plant species.



Detailed Comments/Barriers

- For transmission line ROWs, the crews are supposed to clean equipment in between jobs, not between sites. For substations, the crews are supposed to clean equipment in between jobs, not between sites.
- As part of our general protocol, equipment is cleaned after each use.
- Cost is a barrier.
- Contract language and terms for contractors, staff education, and information.
- Water supply and labor costs are a barrier to this as well as logistics.
- Only practiced when required by regulation. Barriers include additional costs and delays associated with downtime; the additional cost in having cleaning equipment and water available in the field; and potential environmental issues with containing effluent from washing (oil/gas).
- Only in state-regulated areas.
- Current practice is to clean off equipment, tires, and so on, before moving from zone to zone.
- Training on benefits would be needed to implement change.
- Time and staff resources. May be just educating facilities staff or contractors to do so.

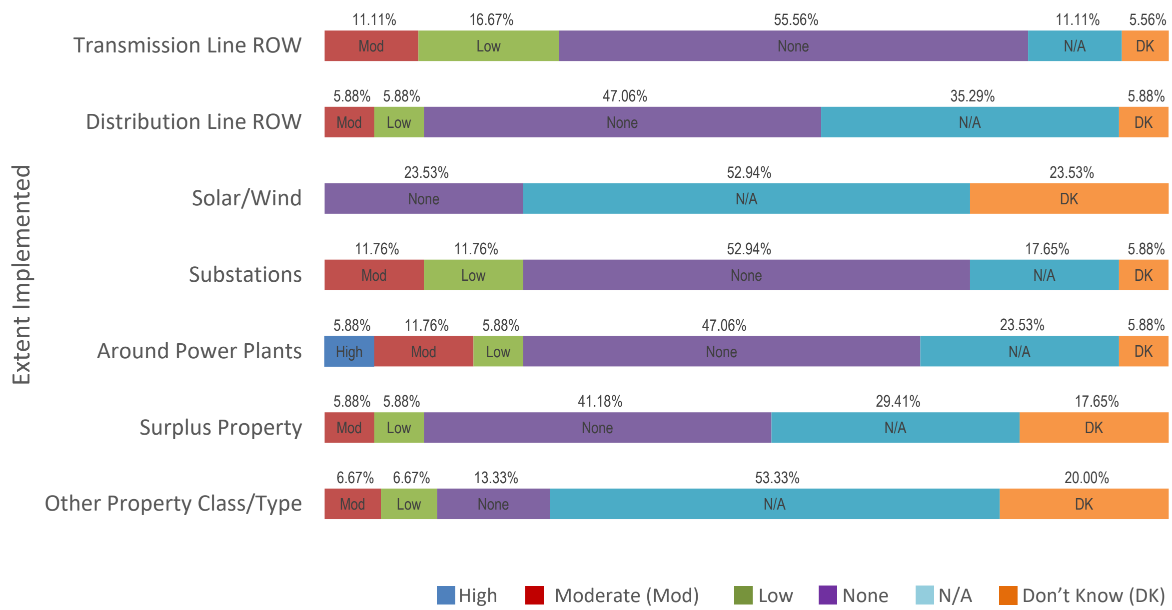
Manage Invasive Species: Time management of invasive plants for periods when they are most vulnerable (for example, before bloom).



Comments/Barriers

- For transmission line ROWs, we may receive notification that there are occurrences of noxious weeds that need to be treated while they are in bloom or after they bloom. Therefore, they may be treated after notification and not be in their most vulnerable state.
- No active removal of invasive plants occurs within our service areas. Our goals are to generally leave the vegetation alone and remove only what causes concern (woody/tall species).
- Our maintenance contractor at substations has used pre-emergent herbicides on many sites this year.
- Seasonal restrictions are difficult to manage for planning and to execute, and there are resource and funding issues. If treatments must be done during certain time periods, impassable sections may not be maintained. If restricted to treatments during autumn/winter, must double resources (crews and equipment), then idle them for spring/summer. Month-to-month budget allocations must be modified to take seasonality into account.
- We have a set season for vegetative control, and a large amount of work must be done on that pre-determined schedule.
- Implemented on some of the conservation areas, but for the larger areas, time and staff resources are limited.

Manage Invasive Species: Before or directly following invasive plant removal on a large scale, ensure that similar or enhanced native floral resources will be available by implementing a revegetation plan.



Detailed Comments/Barriers

- For transmission line ROWs and substations, revegetation with native plant species is done on some capital projects when we collaborate with some federal/state/tribal partners.
- Typically, do not revegetate following weed control unless ground disturbance is involved, when management plans for specific lines and properties (typically on federal lands or as required by project licenses) would require revegetation.
- Cost of reseeding.
- Training on benefits would be needed to implement change.
- For large areas, cost is a barrier along with limited staff and resources.

Brush Management

Scientific and Expert Summary: Brush Management

Brush management performed for maintenance activities by power companies (that is, to transmission or distribution lines) or for habitat restoration can be generally compatible with monarch conservation by opening up the canopy and maintaining natural, open habitat types that support nectar plants and milkweeds.

Some federal agencies responsible for conserving monarch habitat recommend creation and/or maintenance of open, early successional habitat without many tall shrubs and trees (for example, Western Coastal Plain Wildlife Habitation Evaluation Guide [WHEG], USFWS' Monarch Conservation Database). Very few milkweed species thrive in the shady environs of dense forests. Instead, most milkweeds and other flowering forbs that monarchs depend on thrive on forest edges or in more open habitat types such as grasslands, savannas, and wetlands.

Large-scale mechanical removal of problematic shrubs or trees, or selective trimming to partially remove woody vegetation, can benefit pollinators such as monarchs by creating opportunities for nectar plants and milkweed to grow. For example, Zaya et al. (2017) used a long-term botanical survey in Illinois to determine habitat associations and milkweed abundance over time. They found that common milkweed (*A. syriaca*)—which is the primary host plant for monarchs in the Midwest—persisted in sites with few or no trees and that was not too shrubby; the authors concluded that "the management of existing grasslands, such as…woody-species control, may replace some of the milkweed that has been lost from croplands." In another study in Arkansas, Rudolph et al. (2006) found that tree thinning and prescribed fire supported a greater abundance of nectar resources and migrating monarchs compared to untreated controls.

However, it should also be noted that in some habitat types, woody plants may be providing important resources to monarchs and should be left intact. Resources provided by woody plants may include flowering shrubs and trees that provide nectar, shade for developing caterpillars, and roosts/shelter. For example, it is likely that dozens of native blackberry species (*Rubus* spp.) provide nectar to monarchs, as do buttonbush (*Cephalanthus occidentalis*) and sand plum (*Prunus angustifolia*). These native shrubs grow to a maximum height of 8 feet and are therefore unlikely to interfere with transmission wires. At least one tree species with nectar preferred by monarchs grows to 15 feet at most: American plum (*Prunus americana*). And anecdotally, in parts of the arid West, trees and shrubs provide shade that may increase monarch caterpillar survival (Xerces, 2018). Trees and shrubs in riparian areas may be particularly important during migration, because monarch migration routes are associated with rivers in the West (Dingle et al., 2005; Morris et al., 2015).

- ***Experts surveyed had different opinions—likely due to differences in geographic region—about whether controlling woody plant encroachment is beneficial from a monarch perspective.***

Supportive Brush Management Actions

- Where appropriate, maintain open canopy forests with low shrub cover and a high diversity of flowering forbs and shrubs through thinning, brush hogs, mowing, grazing, and prescribed fire.
- If fuels reduction or thinning will involve fuel understory burns, implement outside the active season of monarchs. See the Prescribed Fire section of this report for more information.
- If manually removing woody vegetation:
  - Selectively remove or trim tall-growing woody species rather than removing all trees and woody brush in an area.
  - Leave standing dead trees as snags or dead canes if possible (when not a fire hazard or safety risk). These can provide nesting sites for bees and other wildlife.
  - In appropriate regions, such as in the Midwest or Eastern United States, consider leaving brush piles to decompose naturally, if possible, rather than burning. These can provide nesting and overwintering habitat for pollinators and other wildlife.

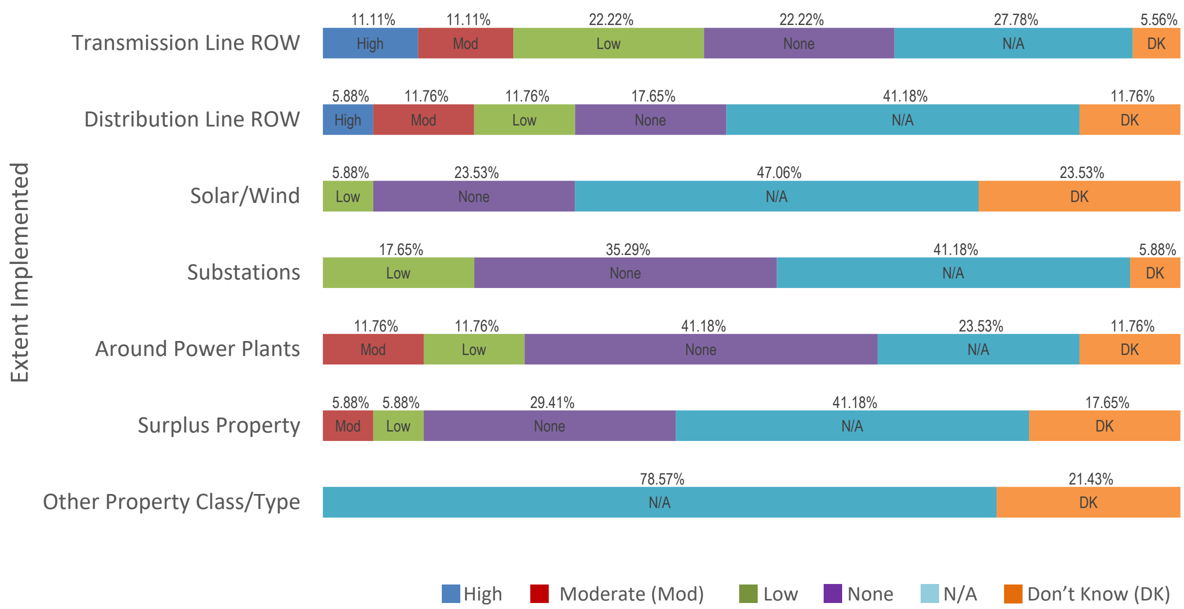
One important exception is found in the range of monarch overwintering habitat found along the Pacific coast in California and Baja, Mexico. Overwintering monarchs are highly dependent on intact forested groves, so brush management (including tree trimming, tree removal, or tall shrub removal) within 110 yards (100 meters) of overwintering sites may negatively influence overwintering monarchs. Consult with a knowledgeable overwintering monarch biologist before undertaking management actions near overwintering sites. Refer to the following documents and pages on Xerces' website for more information: *Protecting California's Butterfly Groves* and *State of the Monarch Butterfly Overwintering Sites in California* and Western Monarch Thanksgiving Count.

Company Survey Results: Brush Management

Extent Implemented:	*Low*
Barriers:	*Moderate-high*
Opportunity:	*Low-moderate*

Overall, implementation of the specific brush control actions included in the Company Survey were low and barriers were moderate to high, with the resulting conservation opportunity being relatively low.

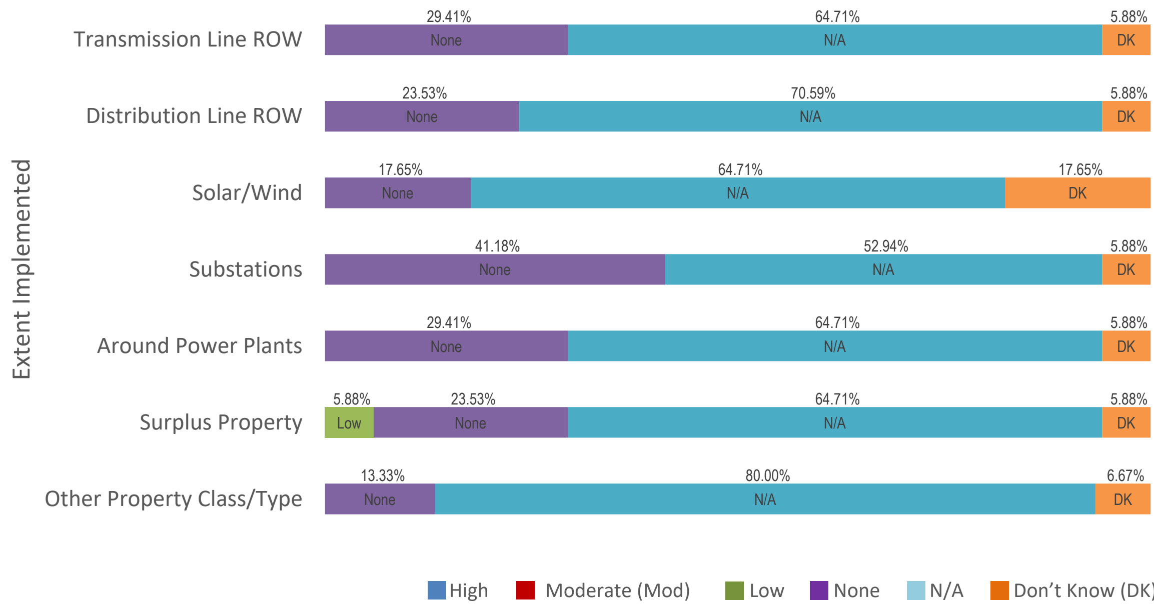
Brush Control: Where appropriate, maintain open canopy forests with low shrub cover and high diversity of flowering forbs and shrubs through thinning, brush hogs, mowing, grazing, and so on.



Detailed Comments/Barriers

- Our goals are to generally leave the vegetation alone and remove only what causes concern (woody/tall species) and foster an environment for low-lying shrubs and plants.
- Brush control is done when necessary to maintain reliability of the electric grid. Brush is cleared when maintenance of a line is required.
- Foresters typically allow shrub layer to develop along transmission and distribution lines.
- Occurs naturally through rotation of 3–6 years.
- Over time, this is the preferred ROW vegetation management practice, but costs of selective vegetation management can delay implementation. It is not appropriate for wind or solar sites where vegetation must be kept low to avoid shading panels or attracting birds. Local requirements and restrictions can be barriers at substation sites.

Brush Control: If fuels reduction or thinning will involve fuel understory burns, implement outside the active season of monarchs.



Mowing

Scientific and Expert Summary: Mowing

Mechanical mowing (including both grass and brush cutting) is used by electric power companies to maintain access road vegetation, keep transmission and distribution lines clear, control invasive weeds, eliminate encroaching woody plants, and maintain lawns and more manicured landscapes at facilities. Mowing may also occur to achieve vegetation clearance and risk mitigation in problem areas such as narrow corridors, subdivisions, and other areas where prescribed fire or other management approaches cannot be used.

In general, when done carefully in herbaceous vegetation, mowing can be an effective management tool for increasing or maintaining plant diversity and monarch habitat. In some parts of the country, early spring mowing is key to removing cool-season weedy annual grasses, and fall mowing can remove litter and aid wildflower seed dispersal. Mowing may also be used to reduce fire fuel loads in the landscape. If done inappropriately—such as too frequently or at the wrong times of year—mowing can have detrimental effects on monarchs and other pollinators. Mowing during the growing season affects pollinators by altering vegetation structure, reducing habitat diversity, and removing floral resources (Morris, 2000; Johst, et al., 2006; Noordijk, et al., 2009; Kayser, 2014) and can result in direct mortality of butterfly eggs, larvae, and adults and destroy topographical features important for shelter (Thomas, 1984; Wynhoff, 1998; Humbert et al., 2010; Kayser, 2014). For these reasons, mowing can cause temporary declines in the local diversity and abundance of butterflies (Munguira and Thomas, 1992; Feber et al., 1996). Weber et al. (2008) found that field mowing every four years resulted in significant decreases in adult butterflies immediately following mowing, but in the years following, rebound was generally robust—especially in large fields in which not all areas were mown in the same year. In Southwest Germany, Weiner et al. (2011) examined pollinator and flower diversity in 40 grasslands and found that diversity and abundance of bees and butterflies decreased with increasing land use intensity (including mowing), likely reflecting lower diversity and altered composition of floral resources.

The time of mowing influences which floral resources are available for pollinators (Johansen et al., 2017). Frequent mowing can reduce native plant species diversity and abundance and may also favor the development of grasses over herbaceous plant species (Parr and Way, 1988; Williams et al., 2007; Mader et al., 2011), which can indirectly affect monarchs and other pollinators. However, moderate mowing levels—such as twice per season—have been shown by multiple studies to increase plant species diversity in grassland habitats (Parr and Way, 1988; Forman, 2003; Noordijk, et al. 2009). Other studies suggest that a single mowing during the growing season (Valtonen et al., 2007) or in the fall (Entsminger et al., 2017) is more beneficial compared to two or more mowings in a year. It should be cautioned that spring or summer mowing, although potentially beneficial to plant diversity in some locations, can lead to direct mortality of monarchs and other pollinators.

Limited research in eastern North America has shown that spring or summer mowing can be used to extend the availability of milkweed plants for monarch breeding. Alcock et al. (2016) found that mowed common milkweed had slightly higher numbers of eggs and larvae compared to unmown and senescing milkweed. In another study, significantly more eggs were laid on newly sprouted common milkweeds than on older control plants (Fischer et al., 2015). Summer (July) mowing and burning can increase green antelope horn 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 (Baum and Mueller, 2015). Bhowick (1994) notes that mowing or clipping of common milkweed (*A. syriaca*) can cause lateral root buds to sprout, increasing milkweed patch size in the long term unless mowing is repeated frequently enough to deplete the plant's energy stores. In the West, showy milkweed (*A. speciosa*) 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.

- ***The majority of experts surveyed said that it is beneficial to mow when monarchs are not present and harmful to mow when monarchs are present. However, experts also identified nuance in mowing recommendations: there may be circumstances in which mowing when monarchs are present is more beneficial to the long-term quality of habitat for monarchs.***
- ***Experts agreed that spot mowing to avoid milkweed and nectar plants is generally beneficial. However, spot mowing is likely more feasible with taller and rhizomatous milkweed species that grow in clumps such as common milkweed (A. syriaca) and showy milkweed (A. speciosa) compared to species that are smaller and grow individually such as green antelope horn milkweed (A. viridis) and pallid milkweed (A. cryptoceras).***

To this end, land managers can focus on achieving a diverse mosaic of habitat types and mowing techniques across the landscape to sustain healthy ecosystems not only for monarchs, but also other insects. This tactic is supported by numerous studies examining the effects of mowing and other intensive management strategies on pollinators and other invertebrates. For example, leaving unmown strips as refugia, delaying mowing until fall—ideally after the first frost—and increasing heterogeneity of mowing (for example, mowing in patches or at different heights) can all help increase the abundance and diversity of native bees and butterflies on managed meadows (Bruppacher et al., 2016; Unternährer, 2014; Buri et al., 2014; Kühne et al., 2015; Meyer et al., 2017).

These conservation actions are meant to be adapted to your region and landholding context.

Supportive Mowing Conservation Actions

- Limit mowing to no more than twice per year. Ideally, sites would be mowed only once each year or every few years on rotation.
- Where possible, vary mowing times/season every few years to increase plant diversity.
- Avoid mowing an entire habitat patch. Aim to mow no more than one-third of an area in one year.
  - Use spot mowing. Focus on areas with invasive plants or other target undesirable vegetation to prevent them from encroaching or spreading seed.
  - Create a mosaic of patches with structurally different vegetation.
  - Leave one or more patches—as large as possible—of habitat unmown for the entire year. These patches can provide important refugia for monarchs and other pollinators.
- Avoid mowing milkweed during the monarch breeding season in your area. (See Figure 6-2 for region-specific guidance on mowing windows for monarchs.)
  - Generally, fall mowing after the first frost is useful to remove dead vegetation, clearing space for emergence of spring milkweed.
  - It is ideal to avoid mowing floral resources and host plants for breeding and migrating monarchs.
- If mowing must occur during monarch breeding season:
  - Delay mowing until as late as possible (late summer or early fall) to provide a longer period for monarch caterpillars to develop and extend availability of nectar plants to monarchs and other pollinators into the late summer.
  - Flag existing milkweed patches, when feasible, and avoid mowing them to conserve milkweed plants and avoid causing direct mortality to immature stages of monarchs.
  - Train people operating mowers to recognize milkweed plants and important native nectar plants so they can be spared during mowing.
  - Adjust mowing height, and do not mow vegetation all the way to the ground. Mow at a minimum height of 10–12 inches to avoid cutting newly emerged milkweed plants in the spring (March–early June) and to allow vegetation time to regrow during the growing season.

  - If mowing on cool days, aim to mow during the middle of the day. Monarch adults are typically most active during the warmer parts of the day, which means they are better suited to escaping a mower.
  - If located in the Southern Great Plains, a mid-summer mow can be timed to avoid negatively impacting immature monarchs and may generate milkweed regrowth in some species such as *A. viridis* used by monarchs. See Figure 6-2 for specific timing recommendations.
  - If located outside the Southern Great Plains, experiment with mowing at a time that could promote milkweed growth. Because information on the efficacy of mowing to promote late season milkweed growth is largely unstudied in many parts of the country and for many milkweed species, land managers are encouraged to document milkweed response and adapt future mowing practices accordingly.
- If invasive species are present:
  - Clean mowing equipment after use and between sites to limit the spread of these weeds.
  - Become familiar with the life-history traits of your target invasive weeds. Some species are stimulated by mowing, so alternative control methods may be preferable when they are present.
  - Time mowing for periods before weeds flower. Avoiding mowing when invasive weeds have seed heads will help reduce the spread of weeds at the site by limiting the number of weed seeds that attach to mowing equipment and potentially get moved to a different site.
  - Control of invasive species generally takes precedence over protecting monarch habitat; however, minimize harm to monarchs and replace lost nectar resources whenever possible. See the Invasive Species and Brush Management sections of this report for more information.

Company Survey Results: Mowing

Extent Implemented:	*Low-moderate*
Barriers:	*Moderate-high*
Opportunity:	*Moderate-high*

Survey responses showed that mowing practices are largely driven by pre-determined vegetation management cycles, site access requirements, and compliance with local ordinances. Because mowing cycles on transmission lines generally occur once every 3–5 years and follow an overall IVM plan, these property types are largely already following frequency-related monarch conservation actions. Other property types that have minimum access requirements and local ordinances, such as substations and around power plants, are often mowed many times per year. Seasonal conservation actions can be difficult to implement due to pre-determined vegetation management schedules and contractor commitments. Mowing that requires plant identification also comes with high barriers. Ownership vs. easement scenarios can impact the ability of power companies to implement monarch conservation actions because they may not have control over the property, for example, where transmission line easements cross farm fields. Properties that are owned may be managed by project partners, such as at solar and wind sites.

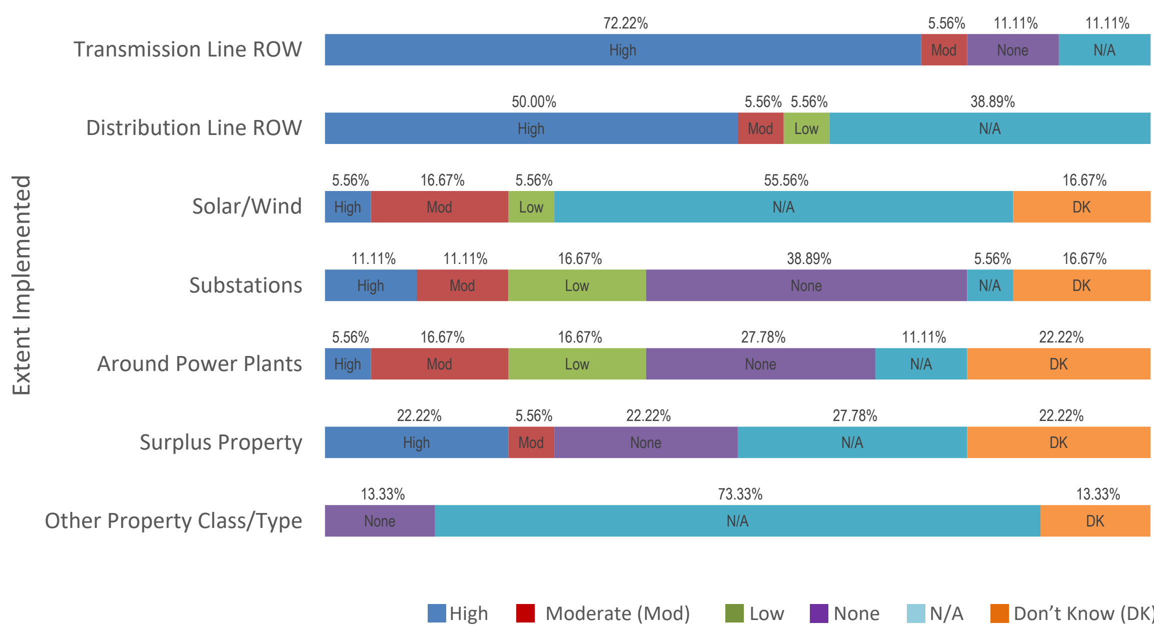
> *Seasonal restrictions are difficult to manage from execution, resources, and funding perspectives. Execution: inclement weather and snow pack make access to ROWs difficult. If all mowing must be done during this season, impassable sections may not be maintained. Resources: if restricted to mowing in autumn/winter, must double resources (crews and equipment), then idle them for spring/summer. Funding: month-to-month budget allocation must be modified to take seasonality into account.*
>
> Anonymous Company Survey Response

Overall, although mowing of transmission lines largely already follows the low-frequency conservation action thought to support monarchs, the seasonally restrictive mowing actions show low implementation and moderate-to-high barriers across most other land asset types.

General Comments/Barriers to Mowing Practices

- Lack of understanding where milkweed is present is a major barrier to implementing milkweed-specific mowing practices (for example, mowing outside the monarch breeding season, avoiding milkweed patches).
- Business case for changing our current mowing practices would be needed.
- Staff education and funding are barriers.
- Easement restrictions limiting our ability to change how the property is managed.
- Solar sites are small and managed by other cooperatives.

Mowing: Limit mowing to no more than twice per year.

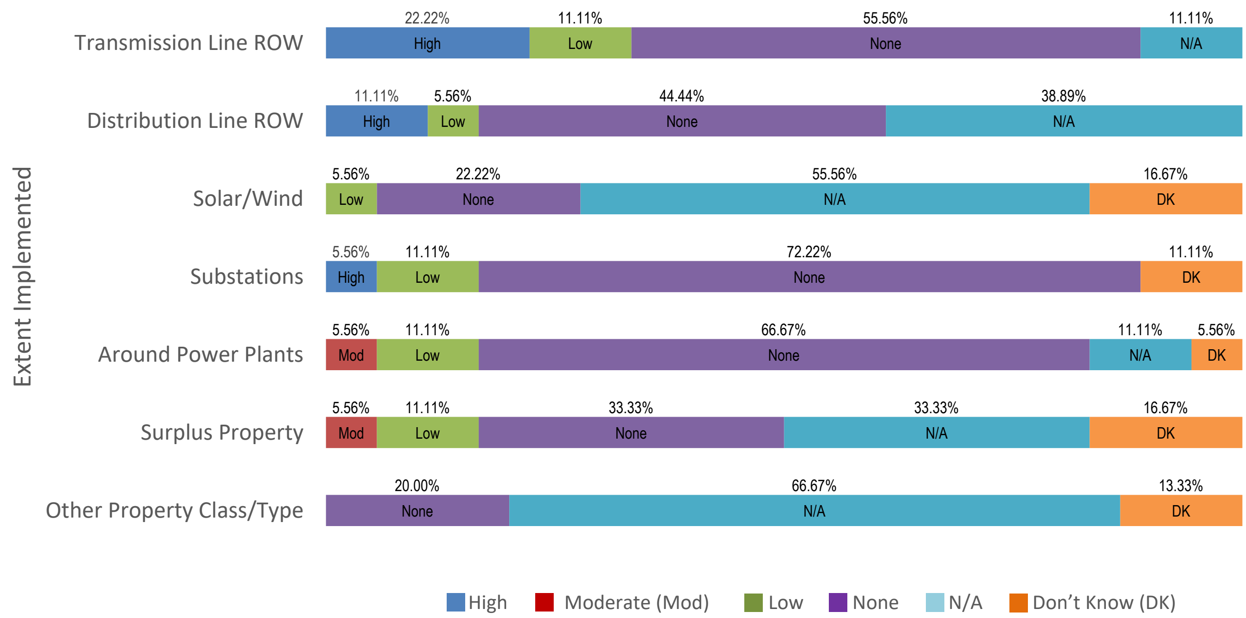


Detailed Comments/Barriers

- At substations, it is considered unsightly and/or a fire hazard to limit mowing.
- We are currently on a 3-year cycle for mowing and herbicide applications on our transmission lines, so only 1/3 of our service territory is mowed annually. Our IVM plan applies only to overhead transmission lines, and any properties around our substations are managed by facilities on an individual basis.
- A barrier is the regulatory environment regarding land management requirements of power plants and hydro sites. Routine management is done no more frequently than once per year.
- This does not apply to our substations and solar sites that are gravel.
- Generally, don't mow under T&D lines.
- A barrier is for our property that is not owned by the company. We have limited control over how the sites where we have easements are managed.
- Foresters prefer to let a shrub layer develop. Mowing is required due to fire hazard during dry season. A minor more natural buffer may be appropriate at some sites, but further evaluation would be needed to evaluate risk vs. benefit. Don't have guidelines in place for mowing at plant sites or surplus property.
- Current management includes multi-year mow rotations; buffers around power plants include forest habitat at some locations.
- Typically, mowing is limited to twice per year or less on transmission ROWs; however, property owners in suburban areas often prefer a mowed "lawn" and consequently the distribution ROW is mowed more often. Local requirements, security concerns, and visibility issues are barriers at substation sites.
- The vegetation on landfill covers and dams must be kept low enough to facilitate inspections, per permit requirements—this often results in frequent mowing.
- Mowing is every 3 to 7 years on the transmission line system.
- Substations mowed 10 times a year to keep presentable to public and keep vegetation from making contact with substation fence. Surplus properties are not in the mowing budget.
- Municipality requirements are barriers to limiting mowing to only twice a year.
- Just clarifying that this is for those properties that are not leased to farmers. The majority (~80%) of our owned properties in transmission lines are leased to farmers who farm or graze mostly as they see fit. If we don't own the site, we cannot manage the owner mowing practices.
- No barriers; the extent of mowing was reduced in the IVM plan. Site maintenance is always set to routine mowing; could be incompatible with site plan and regulatory requirements. Surplus property has various uses and may have a high amount of mowing.
- We typically mow our transmission lines once every few years, but we do not have a limit on other properties. Training on benefits of limiting mowing would be needed to implement change.

- Mowing is highly variable depending on whether it is a transmission ROW that is mowed less frequently than a substation or property immediately around a power plant.
- Surplus properties, which would include around 264,000 acres, vary in mowing depending on whether it is on a dam reservation, which is mowed often, versus lands that we have set aside for conservation and protection purposes, which are not mowed at all or mowed less frequently unless it is an agricultural lease.

Mowing: Avoid mowing vegetation when it includes milkweed during the monarch breeding season in your area (generally between spring and first frost).

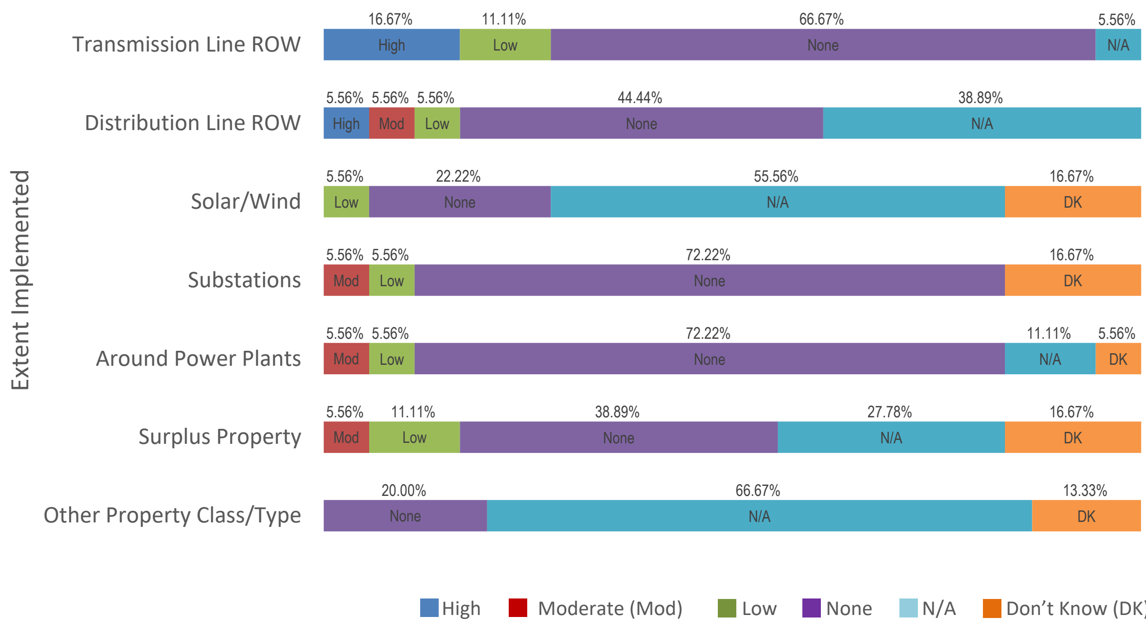


Detailed Comments/Barriers

- On transmission lines, milkweed locations are not mapped on our ROWs. Our Natural Resource Specialists (NRS) and vegetation management contract workers may not know how to identify various milkweed species at different times of the year.
- Mowing is completed based on construction and maintenance schedules and is not impacted by monarch habitat.
- Don’t have knowledge of milkweed presence on company properties. Mowing is required due to fire hazard during dry season. A minor buffer may be appropriate at some sites, but further evaluation would be needed to evaluate risk vs. benefit. Don’t have guidelines in place for mowing at power plant sites or surplus property.
- This is not feasible for T&D due to mow rotation and IVM contracts.
- The low height of the solar panel leading edges (24 inches) necessitates mowing to eliminate weeds that may shade the panels.
- Local requirements, security concerns, and visibility issues are concerns at substations.

- Generally, there is no seasonal mowing done around power plants due to inspection requirements, plant preferences, and so on. However, at two facilities, mowing is controlled to avoid impacts to pollinators.
- Barriers: identifying areas with milkweed and obstacles for contract mowers.
- This simply has not been pursued or considered.
- There is currently no process or plan to avoid mowing milkweed when it is combined with other brush. If it is stand-alone (not part of other brush), there is no concern and it is not mowed (it would be rare that it is not part of other brush being maintained).
- Barriers: staff training; transmission line ROW maintenance is conducted by contractors.

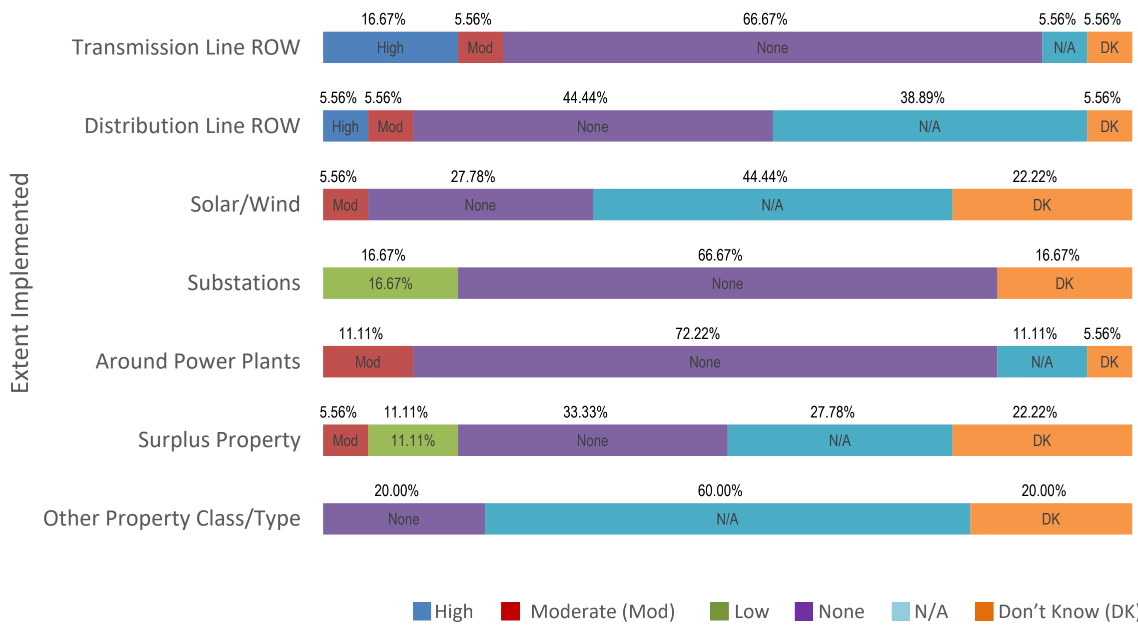
Mowing: Delay mowing until after the monarch breeding and migration season (after late summer or fall, depending on your region).



Detailed Comments/Barriers

- Mechanical mowing is limited to the roadway areas to maintain access according to our IVMP but occurs from late June to early August.
- Mowing is required at substations due to fire hazard during dry season. A minor buffer may be appropriate at some sites, but further evaluation would be needed to evaluate risk vs. benefit. Don't have guidelines in place for mowing at plant sites or surplus property.
- Generally, there is no seasonal mowing done around power plants due to inspection requirements, plant preferences, and so on. However, at one facility, mowing is delayed to avoid impacts to pollinators.
- Have not considered this in the past; now training and informing vendors to not mow.

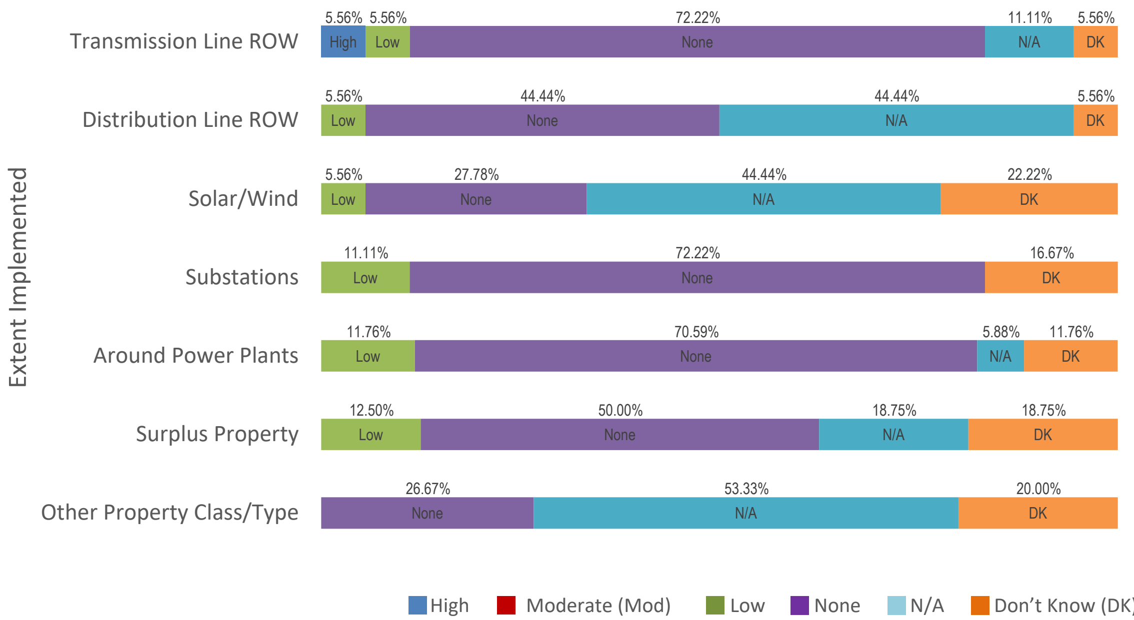
Mowing: Spot mow to avoid milkweed and/or nectar plants; focus on mowing target plants.



Detailed Comments/Barriers

- Only mechanical mowing occurs along the dirt pathways to maintain access for vehicles. Unless a milkweed plant is growing alongside our pathways, it generally won't be cut.
- We do not participate in spot mowing. The response is that spot mowing will increase cost due to constraints on the mowing contractor.
- Training mower operators to identify target plants.
- Barrier is identifying areas where milkweed currently occurs.
- Surplus property varies due to different management objectives.

Mowing: Adjust mowing height to a minimum height of 10–12 inches in areas with milkweed in the spring.



Detailed Comments/Barriers

- On transmission line ROWs, milkweed occurrences have not been identified.
- This could be implemented on transmission and distribution ROWs and most other properties if the mowing equipment was capable. Not likely to be done at substations due to security concerns. Surplus properties are not typically mowed.
- Not feasible with current mowers.
- There is not a management plan in place for this, and staff resources are limited.

Mowing: Mow no more than one-third of a management area per year.

There was confusion among survey respondents regarding this question. Specifically, it was unclear what the definition of *management area* was. It could have been the full system operations (that is, all transmission lines) or one site/line. Due to the confusion, the survey results have been removed and were not considered as part of this analysis.

Prescribed Fire

Scientific and Expert Summary: Prescribed Fire

Prescribed fire is a relatively uncommon management tool used in rights-of-ways and other land holdings managed by power companies. However, power companies are increasingly challenged with managing land after wildfires, particularly in areas of the western United States. Understanding how fire affects monarchs and their habitat is important for planning prescribed fire and managing land after wildfire.

Prescribed fire is an important management tool that, if carefully implemented, can be used to control unwanted woody vegetation and some invasive plants, stimulate wildflowers in fire-adapted plant communities, and reduce litter buildup that can suppress nectar resources for pollinators such as the monarch. However, implementing fire during the monarch breeding season (see Figure 3-2) 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 of using prescribed fire while monarchs are present may outweigh the short-term impacts. When managing land after a wildfire, power companies have the opportunity to incorporate monarch nectar and host plants into post-fire restoration efforts.

There is limited research investigating the potential benefits or detriments of prescribed fire for monarch butterflies and their breeding habitat. The majority of research has been conducted in the eastern United States in grasslands (Rudolph and Ely, 2006; Vogel et al., 2007; Baum and Sharber, 2012; Moranz et al., 2012). The response of adult monarchs has been reported to be positively correlated with the post-fire availability of nectar resources (Vogel et al., 2007), with significantly more monarchs nectaring or using burned areas compared to unburned areas, especially during the first growing season after a fire (Rudolph and Ely, 2006; Moranz et al., 2012).

Prescribed fire may also promote the growth of some milkweed species, although research is limited. In Oklahoma, one study reported that prescribed fire in summer stimulated re-sprouting of dormant green antelope horn milkweed (*Asclepias viridis*), increasing plant density; monarch egg density was also significantly greater a few weeks after the fire (Baum and Sharber, 2012). The authors concluded that summer prescribed fire in Oklahoma provides greater host plant availability for monarchs in the early pre-migration season. In another study in Kansas, spring annual prescribed burning increased the abundance and relative frequency of common milkweed compared to less frequent fire regimes (Johnson and Knapp, 1995).

Prescribed fire is also a recommended management practice to maintain open late-seral tallgrass prairies invaded by junipers or other woody plants for the federally threatened Mead's milkweed (USFWS, 2003). Studies of this species have reported increases in flowering, plant size, and seedling survival of milkweed plants after prescribed fire (Bowles et al., 1998, 2001; Kettle et al., 2000). In addition, Mead's milkweed plants burned by fire put more resources into sexual reproduction, while milkweed plants that are mowed tend to reproduce more frequently by clonal (vegetative) means (Bowles et al., 1998; Tecic et al., 1998). Many species of milkweed in the West are clonal (for example, showy milkweed) and may respond similarly to fire. However, more research is needed to fully examine this and to determine if encouraging sexual over clonal reproduction is more desirable or vice versa.

Baum and Sharber (2012) found that early summer fire increased the density of milkweed and number of monarch eggs per plant, but it is unknown if milkweed species in the West would respond positively to summer fire. In addition, it may not be feasible to conduct controlled burns in the summer in many western locations, given the high fire danger at that time. To avoid causing direct mortality to immature and immobile stages of monarchs and other pollinators, fall and winter burns are generally advised. Spring or summer burns, however, are used to improve temperate grassland habitat for some sensitive butterflies (Warchola et al., 2017; Schultz and Crone, 1998; Warchola et al., 2015; Hill et al., 2017). In these instances, summer burns are implemented in the early morning when temperatures are low (below 26°C) and fuel moisture is high (at least 9%). These conditions reduce peak soil temperature reached during the fire and increase the heterogeneity of a fire, resulting in more unburned skips of habitat; these unburned skips can function as pollinator refugia (Hill et al., 2017). Additional research is needed to determine the optimal timing to burn milkweed species that occur in the West before specific recommendations can be made. There is some anecdotal evidence to suggest that prescribed fire used to control invasive woody vegetation may increase the abundance of showy (*A. speciosa*) and narrowleaf (*A. fascicularis*) milkweed. Native Americans in California historically used fire to encourage the growth of milkweed, whose fibers were used to make hunting nets and other items (Anderson and Moratto, 1996). However, more research is needed to determine the optimal timing of fire to improve habitat for pollinators while minimizing mortality.

Although there is limited research directly focused on fire and monarchs or milkweed, there is a substantial amount of research focused on using fire as a management tool to improve or maintain habitat for other butterflies (Schultz and Crone, 1998; Potts et al., 2003; Vogel et al., 2007; Debinski et al., 2011, Warchola et al., 2017), and there are several synthesis studies investigating the effects of fire on butterflies (Smallidge and Leopold, 1997; Swengel, 2001).

The use of fire in fire-adapted ecosystems is a focal point of conservation for many specialist butterflies and has been the subject of multiple studies (Smallidge and Leopold, 1997; Moranz et al., 2014, Hill et al., 2017; Warchola et al., 2017). Fire is an important management tool to maintain open plant communities by suppressing woody vegetation encroachment and maintaining early successional state native plant communities with abundant nectar and larval host plants (Schultz and Crone, 1998; Panzer and Schwartz, 2000; Kubo et al., 2009; Henderson et al., 2018). The increase in habitat quality is often beneficial for many butterflies in the long term, even if in the short term it causes direct mortality (Schultz and Crone, 1998; Warchola et al., 2017). Carefully timed and implemented fire on a rotational basis in which one-third or less of an area or only small habitat patches of a larger mosaic is burned in any given year can maintain open grassland habitat and increase abundance of nectar plants and larval host plants critical for some butterflies (Schultz and Crone, 1998; Warchola et al., 2017).

Prescribed fire or wildfires may benefit monarchs and other pollinators by increasing wildflower abundance and increasing the number of flowers produced per plant. This can lead to an uptick in pollinator abundance a few weeks or months after a fire (Van Nuland et al., 2013; Moranz et al., 2014). In fire-adapted forests and shrublands, the combination of conifer removal and prescribed fire can increase herbaceous flowering vegetation (Roundy et al., 2014; Bates et al., 2016: Bybee et al., 2016) and/or the diversity and abundance of butterflies (McIver and Macke, 2014; Huntzinger, 2003; Kleintjes et al., 2004; Waltz and Wallace Covington, 2004; Taylor and Catling, 2012).

Although fire maintains habitat for many butterflies that need grasslands, savannas, or woodlands, direct mortality due to fire can result in long-lasting decreases in butterfly populations (Powell, 1995; Swengel, 1996, 1998; Powell et al., 2007; Swengel and Swengel, 2007; Schlicht et al., 2009; Vogel et al., 2010; Black et al., 2014). When applying prescribed fire as a management tool, it is important to consider whether at-risk pollinator species that are highly sensitive to fire are present and to mimic the historical fire-return interval for the habitat type.

Supportive Prescribed Fire Conservation Actions

General Actions

- Manage fire to increase habitat heterogeneity at multiple scales, both within site and between sites.
  - No more than one-third of an area (for example, one-third of an area in continuous habitat under management such as a field) should be burned each year.
  - Include unburned refugia in the burn plan, especially areas that contain milkweed.
  - If you have skips (unburned areas) within your burn units, leave them unburned.
  - The latter two are particularly important if you burn when monarch eggs, larvae, or pupae are on milkweeds, but it is also important to allow and speed up recolonization of burned areas by other pollinators, such as those that pollinate milkweed plants.

Timing and Frequency

- Burn areas with milkweed outside the monarch breeding season in your region (see Table 6-1).
- If burning during the monarch breeding season is necessary for weed control or other management objectives, consider flagging and avoiding milkweed if possible. This practice is likely more feasible with taller and rhizomatous milkweed species that grow in clumps such as common milkweed (*A. syriaca*) and showy milkweed (*A. speciosa*) compared to species that are smaller and grow individually such as green antelope horn milkweed (*A. viridis*) and pallid milkweed (*A. cryptoceras*).
- Avoid burning right before or during spring or fall migration in your area, because fire can reduce nectar availability—perhaps for the entire migration period.
- Burn in spring or fall (generally late October and November) to stimulate flower production of spring-blooming nectar sources.
- Burn a site once every 3–10 years (rotational burning) or longer, depending on the natural fire interval of the site.
  - Consider site-specific natural fire intervals or rotations for prescribed burns. To determine historical fire regimes, consult the LANDFIRE database.
- Consider varying the time of a burn so that one area is not repeatedly burned at the same time of the year.

Table 6-1
General prescribed fire timing for management objectives (all will vary by region and target plant species)

Management Objective	General Timing
Brush control	Spring
Invasive plant control	Late spring
Stimulate flowering plants	Early spring or fall

Adapted from Hopwood et al., 2015

Post-Prescribed Fire Seeding

Where regionally appropriate and plant materials are available, include native monarch nectar plants and milkweed species in post-fire restoration and rehabilitation. See the Restoration and Revegetation section of this report to determine regionally appropriate milkweed and monarch nectar plants.

Company Survey Results: Prescribed Fire

Extent Implemented: *Low or N/A*
Barriers: *High*
Opportunity: *Low*

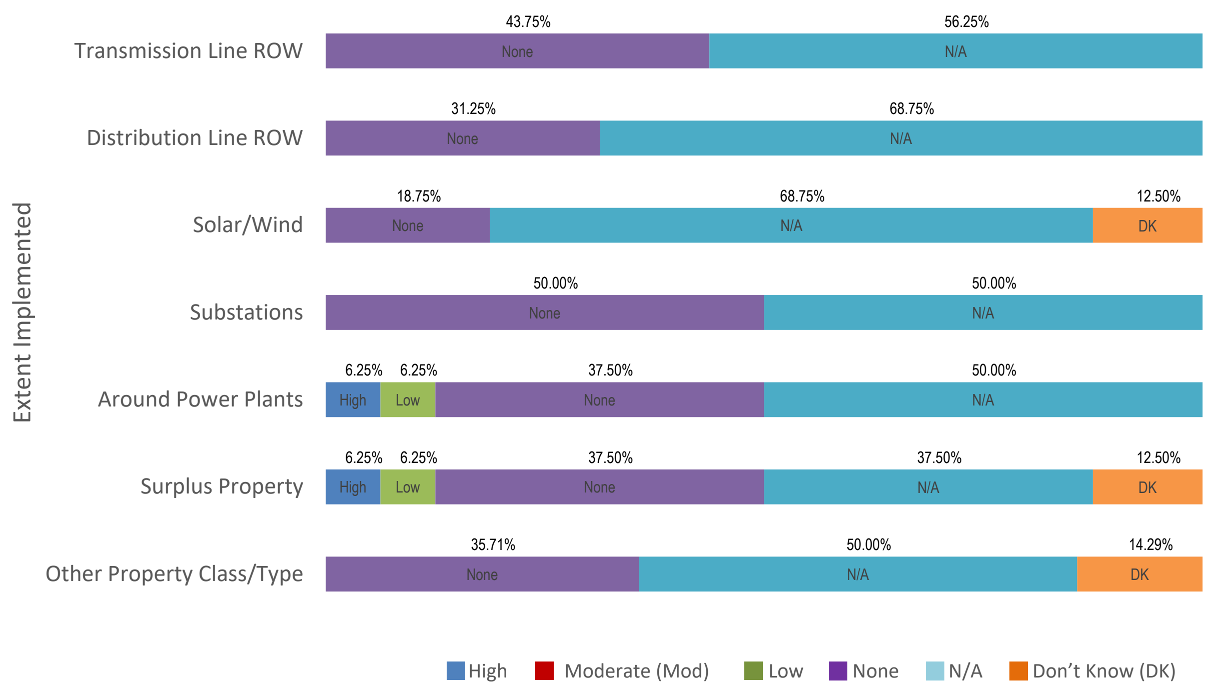
Company survey responses indicated that prescribed fire did not apply to nearly any of the property types, except for a few of the "surplus properties." The survey asked six questions related to prescribed burning, all of which showed similarly high rates of N/A and None responses.

General Comments/Barriers to Prescribed Fire

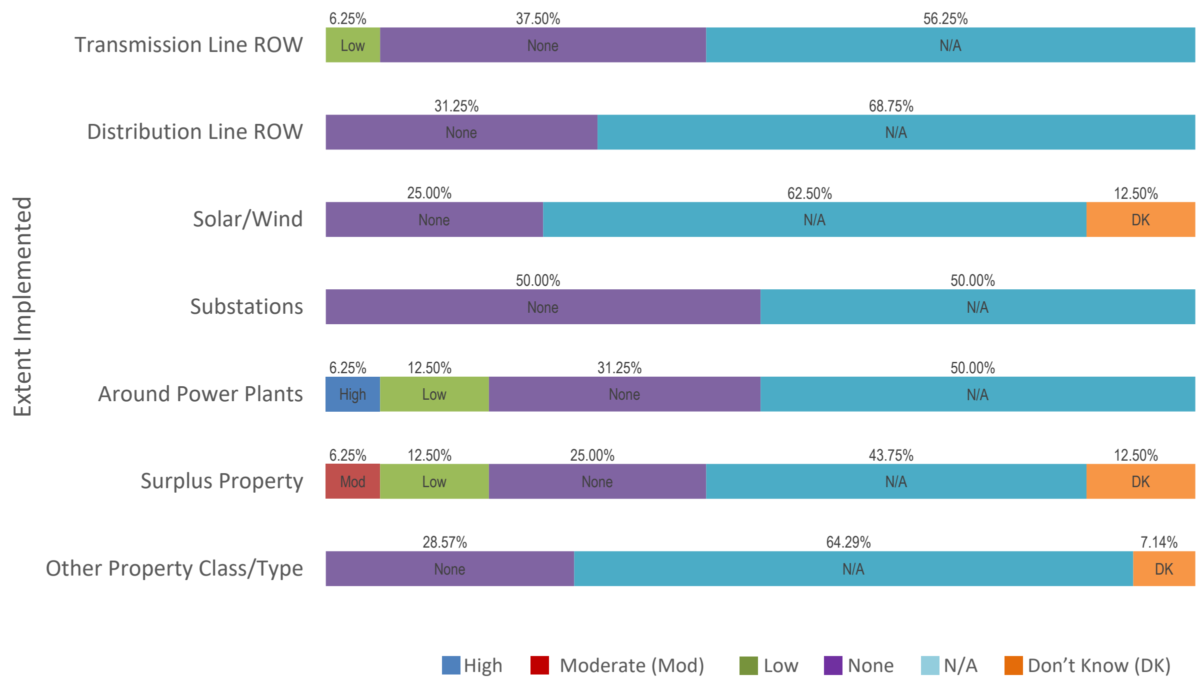
- We are unable to do prescribed burns near transmission lines due to electrical arcing between smoke and energized lines, which could lead to fires and outages.
- At substations, we do not conduct prescribed burns due to the potential to start fires, which could result in outages.
- No prescribed burning occurs with our company.
- Due to the possibility of damage to electric lines and gas lines, no prescribed burning is completed in ROWs. We are evaluating prescribed burns at power plants, but risk to facilities at the plant are a risk/barrier.
- Don't want fire around distribution lines. High percentage of residential areas.
- Wind property is mostly privately owned farmland on long-term leases (only lease footprint).
- Currently don't do prescribed burning, so N/A would apply to all prescribed burning questions.

- Risks to adjacent properties, "flashover" due to smoke and ash, process to obtain approvals, and required weather conditions are all barriers. This has only been practiced at one power plant.
- Do not burn because of possible damage to equipment.
- We don't burn any of these types of properties.
- Burning is mostly done in spring if it is done.
- Currently do very little to no burning in ROWs. In a special case, may do some very small zones, but for all practical purposes, this would be an anomaly.
- We don't use prescribed burning.

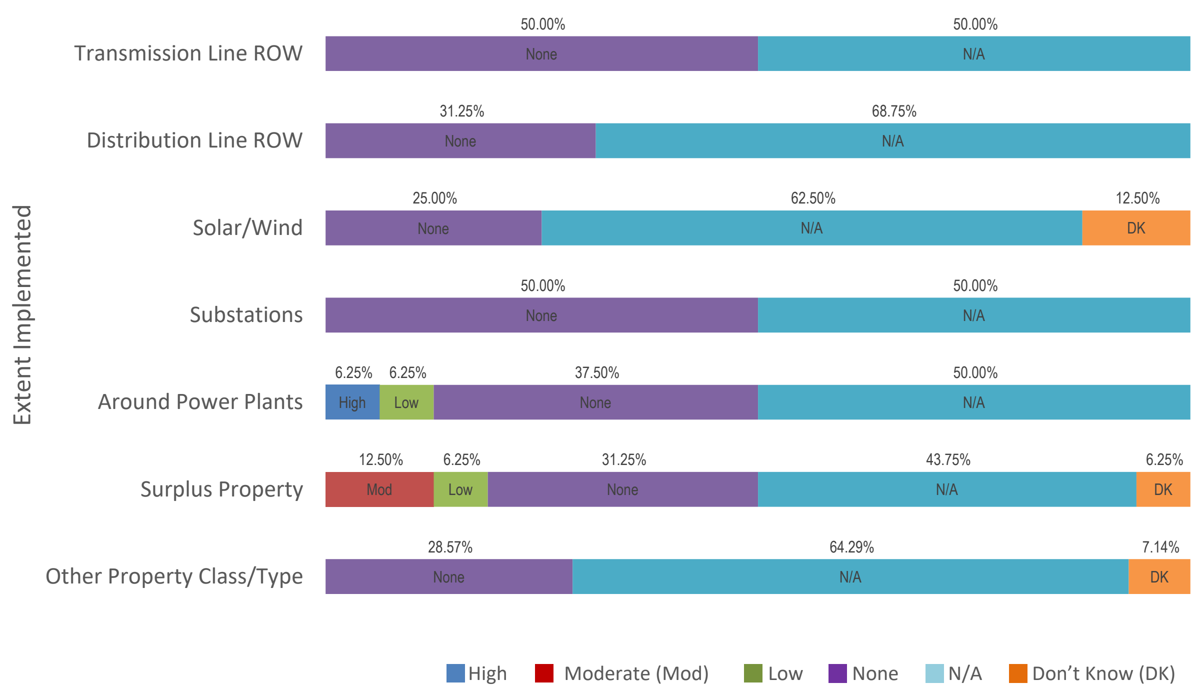
Prescribed Burning: Burn areas with milkweed outside the monarch breeding season in your area (burn windows generally include fall and winter for all regions as well as spring for the Upper Midwest and Northeast (no later than April]) and for the Pacific Northwest and northern parts of the Interior West (no later than May).



Prescribed Burning: Avoid burning right before or during spring or fall migration in your area.



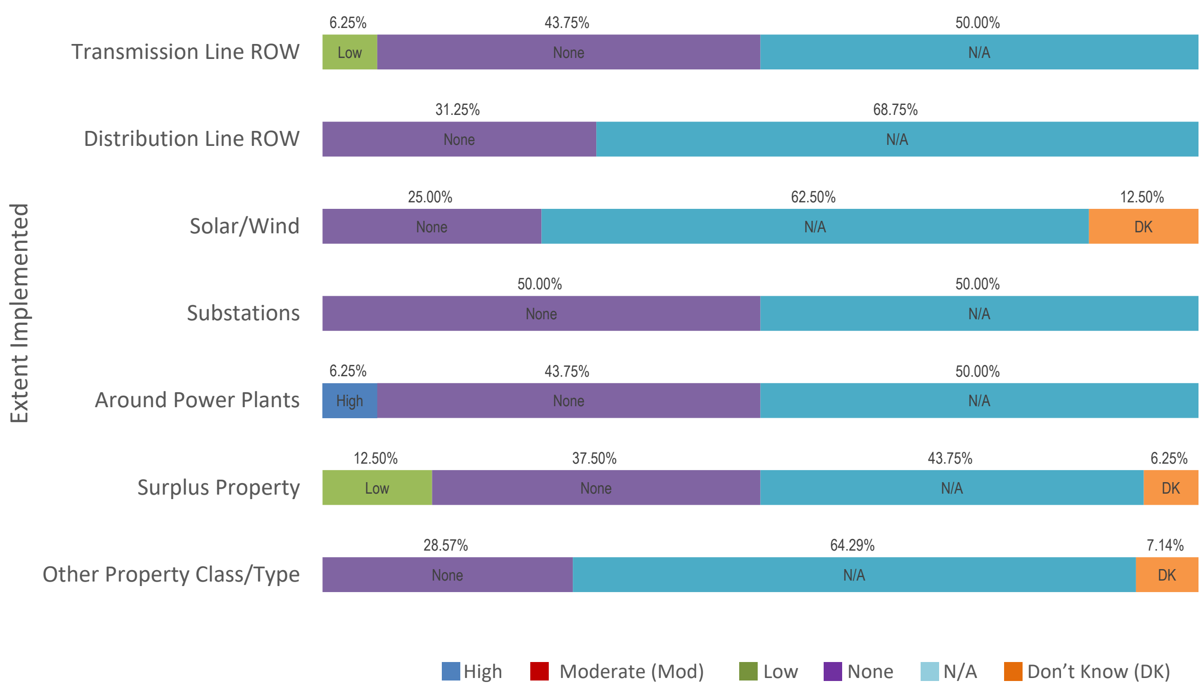
Prescribed Burning: Burn a site once every 3–10 years or longer, depending on the natural fire interval of the site.



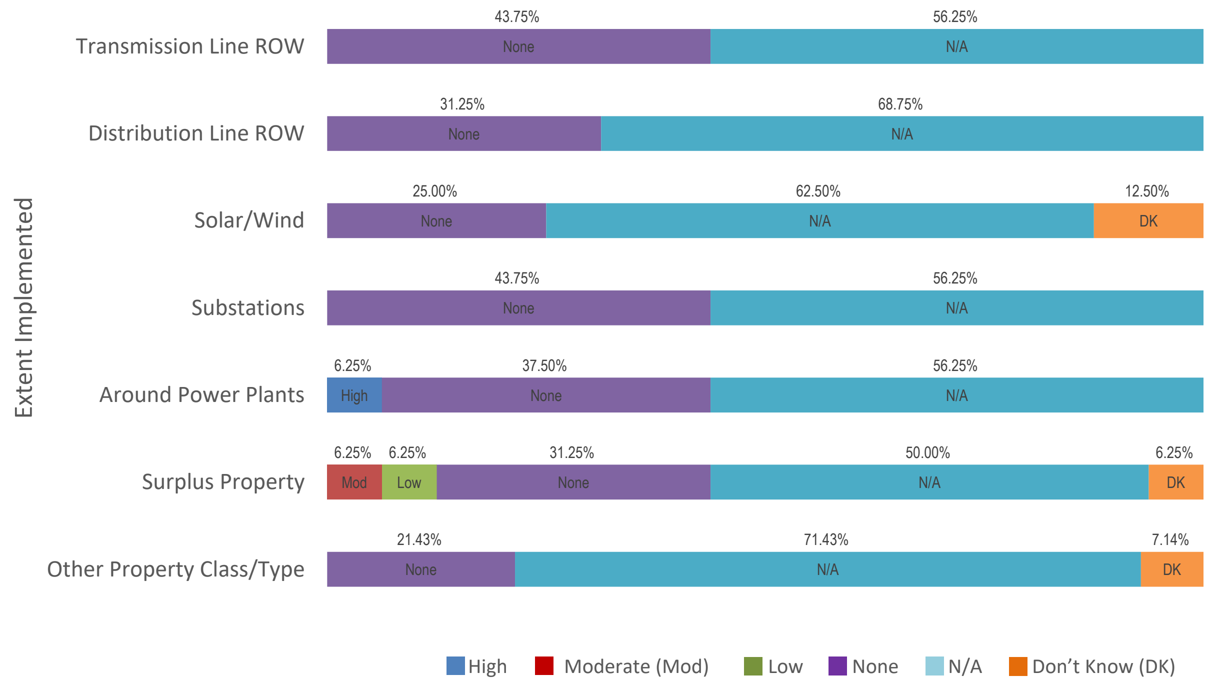
Prescribed Burning: Burn only one-third of a management area per year.

There was confusion among survey respondents regarding this question. Specifically, it was unclear what the definition of *management area* was. It could have been the full system operations (that is, all transmission lines) or one site/line. Due to the confusion, the survey results have been removed and were not considered as part of this analysis.

Prescribed Burning: If you have skips (unburned areas) within your burn units, leave them unburned.



Prescribed Burning: Include native monarch nectar plants and milkweed species in post-fire restoration, if needed.



Grazing

Scientific and Expert Summary: Grazing

Prescribed grazing can be an effective management tool for controlling invasive plants and suppressing woody vegetation to maintain open herbaceous plant communities, but to be compatible with monarch conservation, the timing, intensity, duration, and livestock species must be carefully planned on a site-specific basis. Prescribed grazing is a relatively uncommon practice in rights-of-ways and on lands managed by power companies, but it is used occasionally as a way to suppress woody vegetation and invasive plants (Hopwood et al., 2015). For example, goats and sheep that are readily managed by herding, tethers, or temporary fencing can be used to control broadleaf plants such as invasive weeds or unwanted woody vegetation in areas that are too steep for equipment (Hopwood et al., 2015). However, it is important to recognize that at high density/duration, grazing can also have negative impacts to monarchs and other pollinators by removing host and nectar plants and directly trampling the immature stages of the butterfly (eggs, larvae, pupae). This is another example of how short-term costs must be weighed against long-term benefits for the species.

With so little research directly assessing the effects of grazing on monarchs or milkweed, generalizations must be drawn from research focused on other pollinators to develop management recommendations. Further, the research that does exist rarely reports the grazing stocking rates or timing that would be needed to develop specific grazing recommendations. However, there are some regional grazing management practices already in place that aim to increase or maintain a diversity of flowering plants, including milkweed, for federally listed or sensitive gallinaceous birds, upland game and birds, and fish; these practices will generally also benefit monarch butterflies and other pollinators (Gilgert and Vaughan, 2011; Bates et al., 2016; Dumroese et al., 2016).

Livestock grazing can greatly alter the structure and composition of plant communities and soil structure, hydrology of mesic habitats, and introduce or spread invasive plants (for example, Belsky et al., 1999; Hayes and Holl, 2003; Swanson et al., 2015). Grazing in some ecosystems may also encourage plant community shifts toward invasive plants reducing available suitable habitat for native pollinators (for example, Hanula et al., 2016; Vavra et al., 2007; Kobernus, 2011; Veblen et al., 2015). Grazing-induced changes to the plant community can reduce the availability of nectar and host plants for all life stages of butterflies (Hayes and Holl, 2003; Cushman, 2009). In some studies, the abundance and richness of flowering plants are directly correlated with the abundance of butterflies (Erhardt, 1985; Marini, et al. 2009); therefore, grazing management should strive to maintain diverse floral resource availability for butterflies such as the monarch. However, this is complicated, because the response of herbaceous flowering vegetation to grazing is generally species-specific and often based on plant life-history traits. Plant responses vary with some studies reporting no response (Sjödin, 2007; Batáry et al., 2010), a positive response (Willms et al., 1985; Carvell, 2002; Hayes and Holl, 2003; Marty, 2005; Vulliamy et al., 2006), or a negative response (Damhoureyeh and Hartnett, 1997; Hickman and Hartnett, 2002; Yoshihara et al., 2008; Xie et al., 2008; Moranz et al., 2014).

The response of pollinator communities to grazing also varies widely in the literature (Kruess and Tscharntke, 2002; Vulliamy et al., 2006; Sjödin, 2007; Kimoto et al., 2012; Minckley, 2014b; Elwell et al., 2016). Pollinators may exhibit species-specific responses to grazing dependent on their diet, foraging behavior, and nesting requirements or overwintering behavior (Cushman, 2009; Roulston and Goodell, 2011; Yamhill Soil and Water Conservation District, 2014). In general, research done in western North America shows that as the percent of utilization or grazing intensity increases, bees and butterflies generally decrease in abundance (DeBano, 2006; Cushman, 2009; Kimoto et al., 2012; Minckley, 2014a). If monarchs respond similarly to other pollinators, grazing management that reduces nectar or milkweed plants will likely have negative consequences for monarchs.

Livestock grazing can also cause direct mortality to adult butterflies and immature stages, and some butterflies are sensitive to livestock grazing, such that they will not lay eggs in grazed habitat when ungrazed habitat is available (Stoner and Joern, 2004; Yamhill Soil and Water Conservation District, 2014). It is not known if monarchs exhibit this behavior, but anecdotal field observations suggest that they do not (Stephanie McKnight, personal observation). Livestock can also trample or consume butterfly larval host plants, resulting in mortality to the eggs, larvae, pupae, and even immobile adults (Warren, 1993; Smallidge and Leopold, 1997; Stephanie McKnight, personal observation).

However, when carefully managed, grazing can be an important management tool for maintaining the open herbaceous plant communities such as grasslands, meadows, prairies, and shrublands that are often important to monarchs (for example, Pöyry et al., 2005; Weiss, 1999; WallisDeVries and Raemakers, 2001; Konvicka et al., 2008; Potts et al., 2009; Kobernus, 2011; Vanbergen et al., 2014). Open herbaceous plant communities are also desirable for power company rights-of-ways and other landholdings. Carefully timed and implemented grazing can also be used to suppress invasive plants that can degrade habitat for butterflies and other pollinators (Olson, 1999; Weiss, 1999; Schmelzer et al., 2014; Stonecipher et al., 2016) and are often targeted for control by power companies. In these cases, short-term costs to monarch habitat are likely outweighed by the long-term benefits of restoring an area to better ecosystem function and its value to monarchs in years to come.

Generally, light- to moderate-intensity rotational grazing or short grazing periods followed by a long recovery has been found to be most beneficial to butterflies (Elmer et al., 2012; Hatfield et al., 2015). Due to the variation in responses of both plant communities and butterflies and other pollinators to grazing, careful adaptive management with regular monitoring is advised to ensure that habitat for butterflies such as the monarch is conserved under grazing management plans.

Overall, grazing management can aim to conserve existing milkweed and major nectar plants important for monarchs in their breeding range and migratory pathways as well as conserve mesic and grassland habitats that are often important breeding and foraging habitat for monarchs. Generally, grazing that is of short intensity and duration in the fall or winter is best.

However, because milkweed contains toxic secondary compounds known as *cardenolides*, livestock owners may have concerns about grazing animals in areas with milkweed. Despite the toxicity of milkweed—abundant milkweed can be a sign of overgrazing in some cases—livestock sometimes do consume milkweed even when other forage is available (Stephanie McKnight, personal observation). Livestock eating milkweed can be a toxicity concern (see Technical Box “Toxicity of Milkweed to Livestock” for more information and how to minimize risk); it also reduces available host plants for monarch and may cause direct mortality to immature stages of the butterfly that may be on the plants. For this reason, high-intensity grazing during the milkweed growing season is considered a threat to monarchs and some milkweed species, including the federally threatened Mead’s milkweed (*A. meadii*) (USFWS, 2003).

If grazing occurs during the active growth period of milkweed and monarch breeding season, it is recommended that milkweed be considered in grazing management plans to ensure that they are identified and protected from livestock grazing. Site-specific objectives will need to be developed for the habitat type and species of milkweed in a grazing allotment or pasture. This will allow grazing to be adjusted to conserve existing milkweed populations and habitat for monarchs.

Supportive Grazing Conservation Actions

General Actions

Aim for a goal of maintaining the presence of milkweed, plus a minimum of three nectar plant species in bloom in a grazing management area throughout the season so the system is resilient in supplying nectar. The goal is having multiple species in bloom to create resilience in the system, because not all species or individual plants will produce nectar despite being in bloom. Some species may drop out in some years or may not be abundant enough to support monarchs. This is especially important when milkweed plants are present.

Intensity and Duration

- Keep grazing intensity low (low Animal Unit Months [AUM] for site or allotment) for season-long grazing, or use High-Density Short Duration (HDSD) and/or rest-rotation grazing schemes.
  - Stocking rates should be appropriate for the characteristics of the site, livestock species, and management objectives. Optimal stocking rates will prevent concentrated hoof damage to soils, trampling of milkweed and immature stages (eggs, larvae, pupae) of monarchs, and excess utilization of nectar plants—especially in mesic habitats, areas with large milkweed populations, or areas with documented monarch breeding.
- Keep grazing periods short, with recovery periods relatively long (for example, HDSD grazing; short-duration grazing [Howery et al., 2000]). Rest periods will vary (three months to years) for different habitat types but ideally allow vegetation to adequately recover (plants are flowering, setting seed, and so on) before allowing livestock to return.
- Leave ungrazed refugia across the landscape so monarchs and other pollinators can recolonize grazed areas.

Utilization Actions

- Aim to graze only one-third of a management area (for example, one-third of an area in continuous habitat under management) per year. The ungrazed or minimally grazed refugia within each allotment will serve as reservoirs of pollinators to recolonize grazed areas.
- Aim for utilization rates up to but not exceeding 40% of the current season's growth (Kimoto et al., 2012).
- Consult local wildlife biologists and botanists or local Natural Resources Conservation Service (NRCS) offices to determine regionally appropriate and habitat-specific percent utilization of current year's growth and stubble height limits that will maintain forb diversity and abundance and milkweed for monarchs during the breeding season and spring and fall migrations.

Timing

- If feasible and the soils can withstand it, adjust grazing time to fall or winter grazing when milkweed is dormant and monarchs are not breeding, which is generally between first frost and spring (see Figure 3-2).
- Avoid grazing the same location at the same time every year unless part of an overarching weed management strategy.
- Avoiding grazing during periods in which floral resources are already scarce such as mid- to late-summer.
- Determine a window when grazing will avoid the monarch breeding season and the targeted vegetation (woody vegetation/brush, invasive species) is most vulnerable and palatable to livestock.

- Sheep are particularly prone to eating flowering plants, including monarch host (milkweed) and nectar plants. During the monarch breeding season and in areas with milkweed, sheep should be introduced at low stocking rates and continuously moved to avoid depleting floral resources in any single location.

Livestock Movement

- Establish enclosures or moveable fencing so that livestock can be rotated through grazing allotments to allow recovery of vegetation. If fencing is not an option, geography, water structures, or nutritional supplements might be useful in keeping livestock within a specified area (Stephenson et al., 2017).
- Sheep should be herded regularly and through different routes each year with a 3–5 year rotation of routes used. Sheep should not be allowed to graze one location longer than 1–2 days, and floral resources should be closely monitored to avoid depleting an area of flowering plants during peak summer months (June–September).

Livestock Selection

Table 6-2
Livestock selection considerations

Livestock Animal	Diet Preferences	Browsing Behavior	Animal Management Considerations
Goats	Prefer woody plants, then forbs	Graze selectively; will reach or climb to browse on branches	Can be contained for targeted grazing by portable fencing or tethers
Sheep	Prefer forbs, then grasses	Graze selectively; can deplete floral resources quickly; keep grazing periods short (<1 week)	Can be contained for targeted grazing by portable fencing
Cattle	Consume grasses and wildflowers roughly in proportion to their biomass	Graze somewhat selectively	May need heavier fencing

Table adapted from Hopwood et al., 2015

Flexible and Site-Specific Grazing Plans

Develop site- and habitat-specific grazing plans that can be adjusted for special circumstances such as wildfire, drought, unintended overutilization, sensitive habitat areas, or presence of monarch host or nectar plants.

- Grazing post-fire: One to several years of post-fire rest from grazing may be necessary to allow a plant community sufficient time to recover. This interval will vary depending on ecoregion and site conditions.
- Overutilization: After heavy use or overutilization occurs, livestock should be excluded from the area until it has sufficiently recovered and has the minimum number of flowering

resources recommended above (at least three nectar sources, plus milkweed). The length of rest needed will vary by region and site conditions, but we recommend at least 1 year.

- Drought: Grazing during times of drought has the potential to locally extirpate butterfly populations (Murphy and Weiss, 1988); therefore, reduce grazing intensity and duration to account for drought conditions, and avoid depleting already scarce floral resources. Livestock are also more likely to consume toxic plants such as milkweed during times of drought (McDougald et al., 2001), particularly when the stocking rate is high.
- Native or feral ungulates: In areas with large populations of native ungulates such as elk or deer or feral ungulates such as horses, it may be necessary to adjust the timing, intensity, and duration of domestic livestock grazing. There can be overlap in forage preferences and potentially competition for forage (floral resources for monarchs) among native pollinators, livestock, and native ungulates (DeBano et al., 2016). Avoiding overlap between livestock and native or feral ungulates may help maintain important floral resources for monarchs.
- Sensitive habitats: Consider excluding grazing from sensitive habitats such as riparian areas, springs, seeps, and meadows. These areas support a high diversity of pollinators and provide important breeding and migratory habitat for monarchs. These sources of water are also essential for maintaining the long-term integrity of meadow and grassland ecosystems; disturbing them can have long-term and lasting impacts. Where possible, we recommend fencing sensitive habitats to prevent overutilization.
    - Develop alternative water sources for livestock away from sensitive habitats.

Adaptive Management and Monitoring

Careful tracking of the intensity, duration, and timing of grazing and monitoring of nectar and host plants in response to those variables is key to ensuring long-term habitat quality for monarchs. Grazing management plans should be site-specific and flexible in order to adapt grazing stocking rates, timing, and duration to changing environmental conditions including drought, fire, invasive species, or protection of high-quality monarch habitat.

Toxicity of Milkweed to Livestock

Many plants are classified as toxic to livestock and as a result have been assigned a name with "weed" in it, including milkweed. Milkweed contains plant chemical compounds called *cardenolides* that are toxic to many animals. But cardenolide levels vary by milkweed species and local conditions, causing plants to vary from relatively nontoxic to very toxic to livestock, including sheep, cattle, horses, goats, turkeys, and chickens (FDA Poisonous Plant Database; Panter et al., 2011). Despite their "weed" status, these plants play an important role in the ecosystem, providing nectar for butterflies and bees and supporting a wide range of specialist and generalist beetles, true bugs, flies, and aphids. A large percentage of milkweed species native to North America have also been documented as host plants of the monarch butterfly, which the caterpillars need to complete their life cycle.

Although there have been instances of livestock poisoning from milkweed, the record is sparse and mostly associated with hungry animals being released into dense patches of highly toxic milkweeds or confined to an area without sufficient alternative forage in the western United States (Fleming, 1920). Milkweed plants are toxic to livestock year-round during all growth stages but can be of particular concern when dried—such as in hay—because palatability to livestock increases (Fleming, 1920; DiTomaso and Healy, 2007; Schultz, 2003). Although toxicity varies, all milkweed plants are generally considered toxic to livestock (Malcolm, 1991; Agrawal et al., 2015). However, only two species—western whorled milkweed (*Asclepias subverticillata*) and narrowleaf milkweed (*A. fascicularis*)—have been reported as especially problematic species for cattle and sheep, likely because of their growth forms. Their thin stems and leaves are easily tangled in grasses and are therefore difficult for grazing animals to separate out.

Livestock graze in areas with milkweed all over North America, and there are anecdotal reports of cattle, sheep, and horses eating milkweed even when other forage is available (Stephanie McKnight and Ray Moranz of Xerces, Chris Helzer of The Nature Conservancy, Nebraska, personal observations). Despite this, poisoning events are rare—possibly because livestock must consume a large amount of milkweed to become sick or die, milkweeds tend to have a bitter taste and are avoided by livestock, or because many milkweed species have very low levels of cardenolides. An average cow weighing roughly 1,200 lb will need to eat 12 lb or more (or 1–2% of its body weight) of dried milkweed on average to die of poisoning (Kingsbury, 1964; Burrows and Tyrl, 2007). In a 2017 survey of 43 land managers and ranchers in the West, poisoning events from milkweed were not reported as a major concern, and no one reported firsthand knowledge of a poisoning event (The Xerces Society, 2018).

Is conserving milkweed compatible with livestock grazing? The answer is yes, if you take some basic precautions:

- Maintain an appropriate stocking rate and ensure that livestock have sufficient forage.
- Learn the relative toxicity of the dominant milkweed species in your area.
- Keep livestock driveways and small grazed areas free from highly toxic milkweed species because confined animals may be more likely to eat it. Closely monitor animals that are new to an area where highly toxic milkweed occurs.
- Avoid planting western whorled milkweed and narrowleaf milkweed in areas where grazing is regularly prescribed; these species may cause greater problems for livestock.
- Keep fields that will be used for hay free from highly toxic milkweed species.

In areas where dominant milkweeds have low or no toxicity, stocking rates should be low so that cattle will not substantially reduce milkweed populations.

Company Survey Results: Grazing

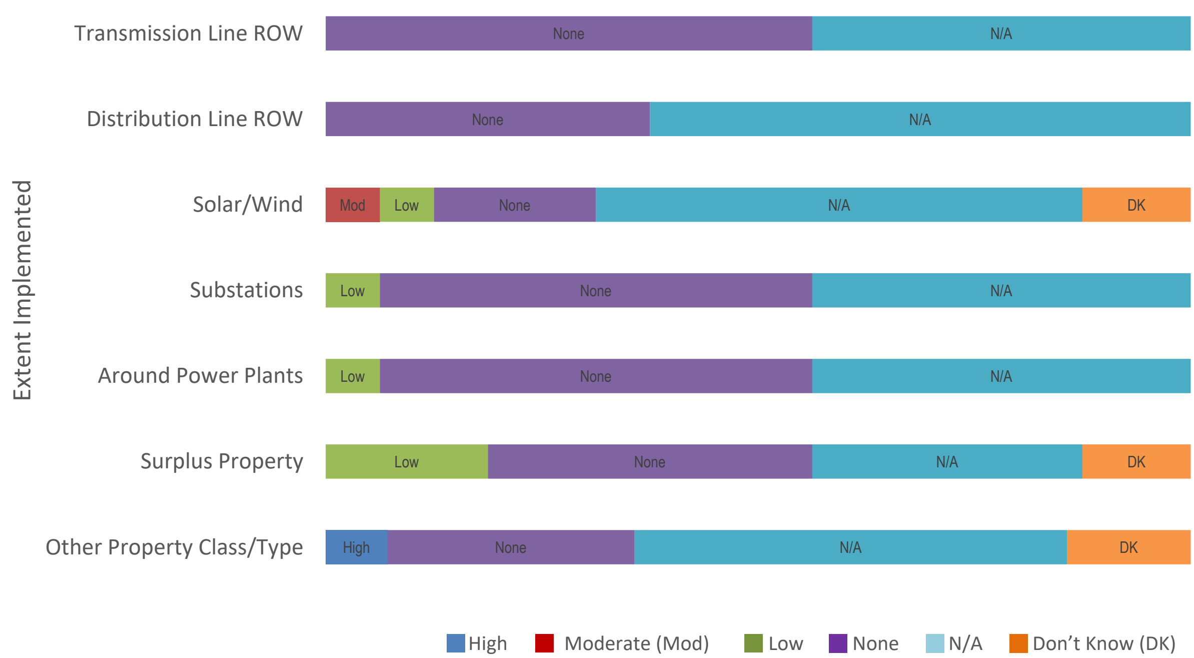
Extent Implemented:	*Low or N/A*
Barriers:	*High*
Opportunity:	*Low*

Similar to prescribed burning, company survey responses indicated that grazing was not used and/or applicable across all property types. The survey asked five questions related to grazing, all of which showed similarly high rates of N/A and None responses.

Comments/Barriers: Grazing

- Transmission line ROW: Grazing on easements is not controlled by us, but rather by the underlying landowner. On fee-owned lands, this requirement is not included in any agreements with real property services, probably because we have no enforcement mechanism or it was not thought of at the time.
- Substations: no grazing occurs on our fee-owned substation lands that we know of.
- No grazing occurs within our company.
- We don't have grazing on our properties.
- Currently do not manage properties with grazing.
- Grazing occurs on easement property and is not within our control.
- Grazing is not controlled on property that is not owned in fee. Per lease agreements, intensity is limited at company wind farms. Local restrictions and security issues prevent implementation at substations.
- Around power plants and on surplus properties, grazing is managed per lease agreements, but livestock managers need to cooperate and see value in the practice.
- Grazing intensity is mostly left up to the lessee. In rare cases, we have intervened if it becomes an issue. Transmission and distribution ROW is almost entirely managed by easements, so grazing intensity would be up to the landowner.
- Grazing is compatible with management objectives of surplus property.
- We have phased all grazing leases out; most of those parcels now are managed for hay or crops or were allowed to return to natural state.

Grazing: Keep grazing intensity low (low Animal Unit Months [AUM] for site or allotment) for season-long grazing or use High Density Short Duration (HDSD) and/or rest-rotation grazing schemes.



Grazing: Graze only one-third of a management area per year.

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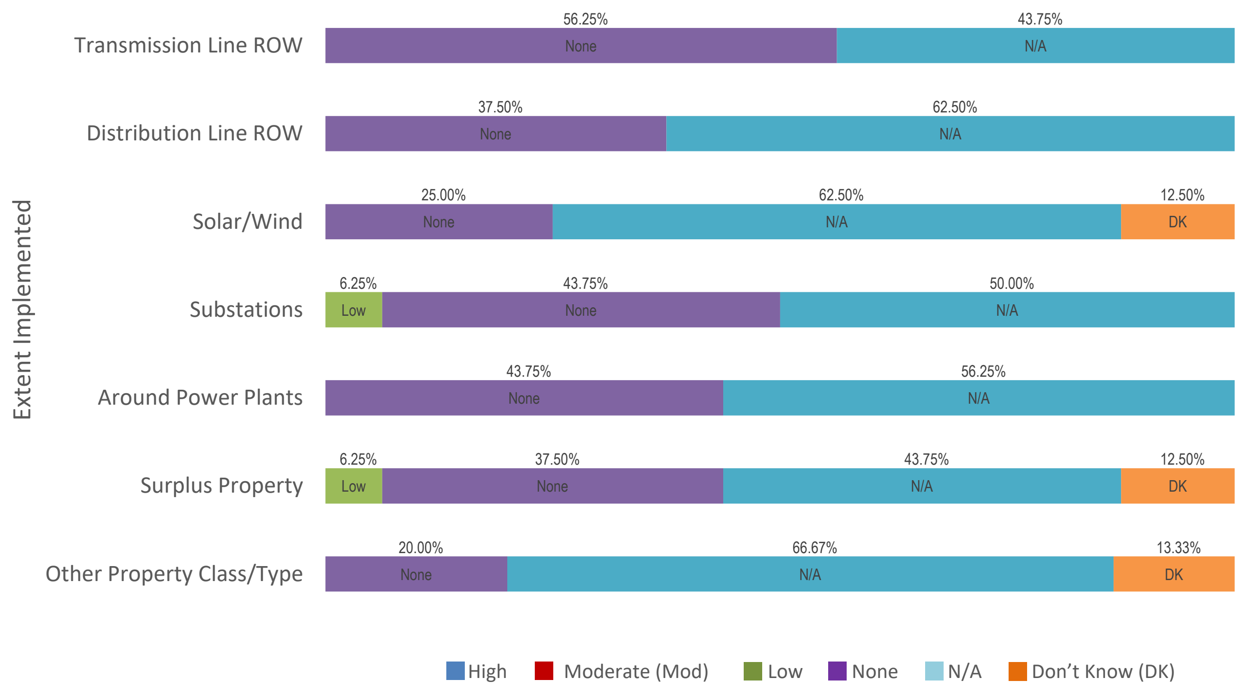
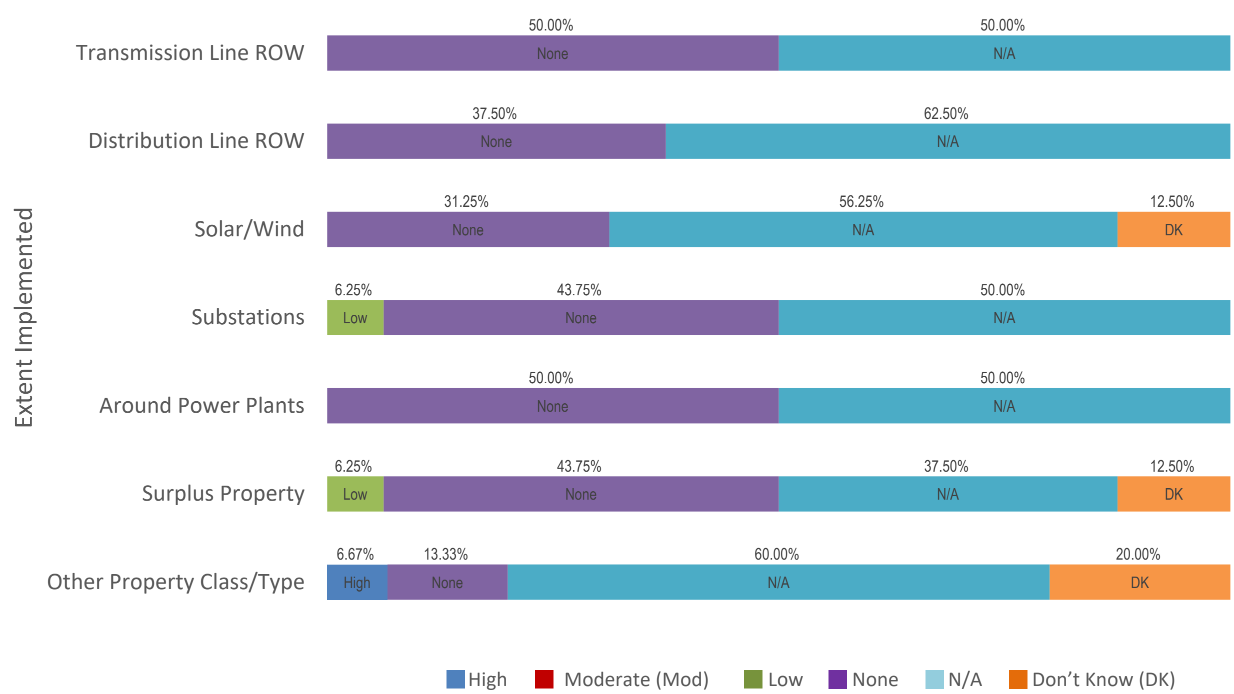
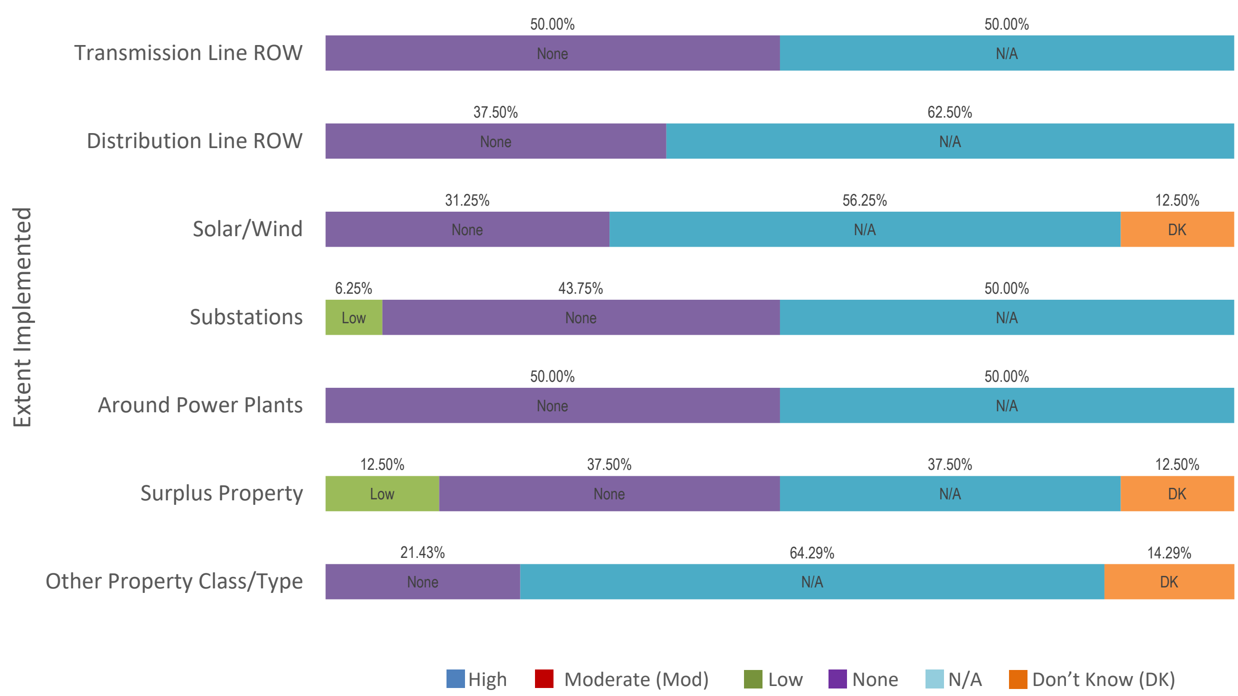
Grazing: Utilization rates up to but not exceeding 40% of the current season's growth.



Grazing: Adjust grazing time to fall or winter grazing when milkweed is dormant and monarchs are not breeding, which is generally between first frost and spring.



Grazing: Avoid grazing the same location at the same time every year.



Restoration and Revegetation

Scientific and Expert Summary: Restoration and Revegetation

Monarch-friendly habitat restoration and revegetation can be incorporated into transmission and distribution rights-of-way, under and around solar arrays, wind turbine fields, buffers acres surrounding power plants and substations, property leased to farmers, and other landholdings. Ecological restoration with a focus on monarchs will be most effective if focused on geographic areas where breeding and migratory habitat has been lost (see Priority Areas for Habitat Conservation and Restoration of this report for more guidance), but nearly any restoration project in the contiguous United States can incorporate some features that can benefit monarchs.

Before considering undertaking a monarch habitat restoration or revegetation project, it should be re-emphasized that identifying, protecting, and managing **existing** habitat to maintain its value for monarchs is generally more beneficial and less costly (for example, time, money, resources) than restoring or revegetating to create monarch habitat from scratch.

- ***All experts surveyed said that protect existing monarch habitat is very beneficial.***

However, in some situations, habitat restoration or revegetation on power company property can be an important way to support monarchs **in addition** to protecting existing habitat. These habitat projects can be important parts of the "all hands on deck" approach to restoring monarch habitat throughout the butterfly's range (Thogmartin et al., 2017a). In other situations, habitat restoration or revegetation may already be underway, and these projects can be made more monarch-friendly by following the supportive conservation actions described in this report. For example, revegetation efforts after disturbance such as transmission line or facility construction (for example, capital projects) are often focused on goals such as soil stabilization, but, if done carefully, can also be an effective management tool to maintain native plant diversity, manage invasive weeds, and benefit monarchs by increasing floral resources and host plants. Adapted to local conditions, native plants are often better equipped than nonnative species to survive droughts and require fewer inputs such as fertilizer and water during establishment. Due to strong root development, stands of native vegetation can provide effective erosion control (Quales, 2003) and help reduce runoff in the spring and improve soil infiltration to replenish groundwater (Bugg et al., 1997; Harrison, 2014). Under some conditions, native plants may have a competitive advantage over nonnatives. Revegetation with native, flowering, perennial seed mixes results in better resiliency against invasive species and improved pollinator forage when compared to forage annual seed mixes, exotic species mixes, or no seeding (Eastburn et al., 2018).

As described in the Monarch Habitat section of this report**,** the principal features of high-quality monarch habitat are 1) native milkweeds to provide food for monarch caterpillars and nectar for adults, 2) flowers, ideally a diversity of native species with overlapping flowering phenologies, to provide nectar for adults, and 3) protection from pesticides.

Eggs and caterpillars require milkweed to complete their transformation into an adult butterfly; there are often multiple generations produced in an area, so it is important to provide milkweed plants as larval hosts during the time period when monarchs are present (see Figure 3-2). Native milkweed can be incorporated into many restoration or revegetation plans but may not be appropriate in all geographic areas or habitat types where native milkweed species do not naturally occur (for example, conifer forests, high-elevation areas, or areas close to overwintering sites in coastal California).

Adult monarchs require an abundance and diversity of nectar during spring and fall migration and during the breeding season. Nectar is particularly important during fall migration when monarchs need energy to make their long flights to Mexico or California. Due to the diversity of plant species that monarchs nectar on, nectar resources can be incorporated into nearly any restoration or revegetation plan and are likely to be compatible with management for other species of conservation concern.

- ***All experts surveyed said that it is beneficial to increase the use of native milkweed species and native nectar species in seed mixes used in reseeding/restoration efforts.***

Supportive Restoration and Revegetation Conservation Actions

General Actions

- In areas with a previously established native plant community, removing invasive plants and following up with targeted weed control methods may allow the native vegetation to fill in.
- Plant or manage for a minimum of one native milkweed species (if appropriate), choosing regional species most suited for the soil type.
- Plant or manage for nectar species, ideally native, which will provide floral resources throughout the breeding and migratory season, aiming for at least three species in bloom at any time between spring and fall.

- Preparing the site prior to planting by reducing existing vegetation as well as managing annual and perennial weeds following planting are critical to plant establishment.
- Irrigate for early plant establishment when using transplants as needed (for example, in arid areas).
- Prioritize the use of locally (or regionally if local is unavailable) sourced native plant material.
- Interseed to improve the diversity and abundance of nectar and/or milkweed species in existing stands of vegetation that have lost diversity (see the Monarch Conservation Resources section of this report for guidelines).
- Keep monarchs and their habitat safe from pesticides by prioritizing new restorations in areas that will not receive insecticide drift.

Site Selection

- Conduct a site inventory to determine if milkweed or monarch nectar species are already present and abundant on a site.
- Prioritize sites without invasive weeds that may impede restoration efforts. Consider whether the seed bank may contain problematic plants.
- Consider which necessary or desirable management activities (mowing, invasive species management, irrigation, and prescribed fire) are possible or not possible on the potential site. Keep this in mind as well as accessibility when choosing sites.
- Select sites for restoration that are protected from pesticides.
  - Consider past pesticides applications, especially residual pesticides and long-lived neonicotinoid insecticides. Local, state, and extension soil laboratories can test soil for pesticides, soil fertility, and microorganisms. See the Herbicides section of this report.
- Soil type is an important factor to consider when selecting plant species for restoration. Consider the following:
  - Some native plants (including many milkweed species) grow better in specific soil types such as sand, silt, clay, or loam. Select species that will perform well in the soil type targeted for restoration (for example, species known to grow in the soil type present).
  - Soil drainage and moisture retention are also important considerations. Some species may have a higher chance of establishing and long-term survival in microclimatic niches with moisture retention, such as those that hold snow later in the season (north-facing drainages or slopes). Others may do better in well-drained rocky soils.
  - Soil information can be determined using local soil surveys and the NRCS Web Soil Survey.

Size of Restoration

Because of their high mobility, restoring even small areas of monarch habitat can provide some benefit to monarchs. However, take advantage of opportunities to create additional suitable habitat (number of habitat areas and the size of each) and to connect habitat areas to each other to provide benefits to other species of wildlife such as less mobile pollinators and beneficial insects. For example, to support native bee pollinations, an area considered ideal for habitat restoration should be at least 1/2 acre in size, with 2 acres or more providing even greater benefits (Kremen et al., 2004; Morandin and Winston, 2006). At a landscape scale, electric power companies have the opportunity to create "stepping stones" as well as corridors of contiguous monarch habitat that extends across a diversity of landscapes; the I-35 "Monarch Highway" in the eastern United States is an example. Creating local- and landscape-scale habitat corridors will increase restoration projects' positive impact on monarchs as well as other wildlife.

Site Preparation

Site preparation is very important and is a key step to successful revegetation and restoration efforts. By removing or suppressing existing vegetation, new seedlings are better able to establish. Taking care to prepare the area and address issues early on may require more effort up-front but, in the long run, tends to make projects more successful and save staff time and money.

- Soil and site preparation techniques may include the following (Vaughan et al., 2013; Foltz Jordan et al., 2016):
  - Repeated herbicide applications to burn down existing vegetation
  - Non-herbicide weed control options include:
    - Solarization (for small areas)
    - Smother cropping (for small areas)
    - Repeated shallow cultivation (cost effective)
    - Sheet mulching (for small areas)
    - Soil inversion (cost effective)
    - Sod removal (for small areas)
    - Prescribed fire (cost effective)
    - Spot weeding and hand-pulling (for small areas)
- If perennial invasive species are a concern, it is especially critical to control them prior to planting.
  - Remove invasive species from the planting area using broad spectrum herbicides, selective herbicides (if applicable), or non-herbicide weed control (see list above). Multiple treatments and seasons may be needed, depending on weed pressure.
  - Following weed control, avoid disturbance that may bring buried weed seeds to the soil surface.
  - In areas with a previously established native plant community, removing invasive plants and following up with targeted control methods may allow the native vegetation to fill in.
  - If revegetating the treated area, choose persistent native species with competitive advantage over invasive species for seed mixes. Consider high seeding rates, and/or starting from container plants rather than seeds.

- A seeding rate of between 40–60 seeds/square foot is typically recommended for meadow-type plantings that include wildflowers and grasses.
- Allow time for habitat to establish and pollinators to recolonize.
  - Revegetating a site can take several years, especially when establishing perennial species by seed.
  - Active weed control (for example, herbicide use for perennial species, mowing of annual weeds) will likely be needed during this time.
  - Set clear expectations between those implementing the work and the landowners or project managers.
  - If creating habitat in an area viewable by the public, consider signage to explain the restoration process or the end goals of the planting.

Species Selection

- Select species that are native to the area.
- Select species that are adapted to the site conditions, including light availability, moisture and soil type.
- Choose plant species that will complement or fill gaps in existing native vegetation. For example, if a site lacks late-blooming species, consider including late-blooming asters and goldenrods in the seed mix or planting plan to support migrating monarchs.
- Include native grasses for their habitat value to pollinators and other wildlife and because these plants fill important niches that help the planting resist weed invasion. Native grasses are important components to seed mixes but must also be carefully balanced to ensure that the grasses do not outcompete forbs. Following are basic recommendations for including grasses in monarch habitat restoration seed mixes:
  - Include 45–65% grasses by pure live seed (PLS) seed count in most seed mixes. For sites in drier climates, the grass component may need to be higher. For sites with more rainfall, the grass component may need to be lower.
  - Prioritize small-statured, highly clumping grasses.
  - Include native rhizomatous grasses at a much lower rate (~5%), but do include them.
- Anticipate impacts of climate change on plant communities, and prioritize species and/or source populations that are likely to thrive under the conditions expected for your area (for example, hotter summers, more frequent drought, reduced snowpack).

Milkweeds

Select milkweed species native to the area. To determine if a milkweed species is native to the restoration site, refer to the USDA Plants Database, Biota of North America (BONAP), the Western Monarch Milkweed Mapper, local herbaria and botanists, or online herbarium consortia. In addition, select species that are appropriate for the habitat in which they will be planted. As an example, if the site conditions are dry or if drought is expected to become more frequent under climate change scenarios in your area, select milkweed species that are adapted to dry conditions.

For example, swamp milkweed (*A. incarnata*) is associated with wet meadows, stream banks, and so on and may not be very tolerant to drier soil conditions. In contrast, butterfly weed (*A. tuberosa*) grows in dry prairies and will grow well in a dry habitat site.

If regionally appropriate, use multiple native milkweed species to provide leaves and flowers across early, mid, and late seasons. For example, in California, California milkweed (*A. californica*) and heartleaf milkweed (*A. cordifolia*) are the first to emerge in the spring and provide important early season resources. Narrowleaf (*A. fascicularis*) and showy milkweed (*A. speciosa*) have long growing seasons extending into the fall. By planting all these milkweed species at a site, the availability of host plants for monarchs to feed upon is longer and more reliable. Research from eastern North America found that adult monarchs laid more eggs when presented with four plants of different species of milkweed, compared to four plants of the same species (Pocius et al., 2017).

Do not plant nonnative species of milkweeds that don't die back in the winter. These "evergreen" milkweeds accumulate pathogens that can be harmful to monarch butterflies.

The nonnative, tropical milkweed (*A. curassavica*) has been shown to increase the rate of *Ophryocystis elektroscirrha* (OE) infection (Satterfield et al., 2016) in areas where it is able to persist year-round. OE infections decrease monarch fitness, including reduced body mass, lifespan, mating success, and flight ability (Altizer and Oberhauser, 1999; Bradley and Altizer, 2005; De Roode et al., 2007; De Roode et al., 2008; Altizer and De Roode, 2015). Nonnative evergreen milkweeds such as tropical milkweed and balloon plant (*Gomphocarpus* spp.), can create reservoirs of OE that have negative impacts on monarch health and have been linked to lower migration success in the monarch population (Altizer et al., 2015; Satterfield et al., 2016). This is of particular concern in parts of California and the Gulf states where climate change may increase year-round breeding on nonnative milkweed (Malcolm, 2018).

Nectar Plants

- Select species that provide a diversity of bloom times to support monarchs throughout the breeding season and into migration: aim for three species of blooming plants known to be visited by monarchs in each season (spring, summer, fall). Including a diversity of nectar plants will create a resilient habitat so that nectar sources are available even in years in which multiple species die back or occur in low numbers (for example, in times of drought or frequent disturbance). Late-blooming (fall) species provide critical resources for monarchs to migrate and build their energy reserves before entering winter dormancy (Brower et al., 2006).
- Depending on the habitat type, select a mix of native, monarch-attractive forbs and shrubs (use nearby natural areas or local resources as references). Prioritize, including a diversity of perennial forb species over annuals. Perennials are more likely than annuals to bloom during times of drought and can provide critical resources for pollinators when annuals are not available (for example, rabbitbrush; Griswold and Messinger, 2009). (See Appendix C for resources.)
- Remember that it is not just about flowering wildflowers and shrubs. Native trees such as American plum (*Prunus americana*) and willows (*Salix* spp.) can provide nectar for monarchs, and many species of trees provide shade and roost to monarchs. And although

milkweed and flowering plants provide the resources monarchs need most, restoration projects should aim to provide for more than just monarchs.

Sourcing Milkweeds and Nectar Plants

If buying plugs or container materials from a nursery, ensure that the plants have not been treated with systemic insecticides such as neonicotinoids which are known to negatively affect monarch larvae and other insects (Krischik et al., 2015; Pecenka and Lundgren, 2015).

Ask the supplier where the seeds and/or plants originally came from and where they were grown. Ideally, use seeds and/or plants that originated nearer to the habitat site so they are adapted to local conditions and part of the local ecosystem.

The source of the native plant material impacts the quality of the revegetation and restoration projects and their value to native pollinators, including monarchs. Plant material from areas with a different climate, soil, or other abiotic or biotic conditions may be less adapted and may not establish as well. Where available and economical, using local ecotypes for native seed and plant material is ideal; where local sources are not available, regional sourcing may be necessary. Local ecotypes are adapted to the area and will reduce any potential undesirable gene flow with wild plant populations—including for milkweed (Borders and Lee-Mäder, 2014). To source local ecotypes of native plant materials, follow provisional or empirical seed zone guidelines for your region in accordance with the National Seed Strategy. For milkweed, consider using provisional milkweed seed zones (see Landis, 2014) which is based on ecoregions. Ask your supplier about the origin and provenance of the seeds and/or plants to ensure that they are local or regional ecotypes.

It is also ideal to select plant sources and collect plant materials to achieve high genotypic diversity (multiple locations or populations), which supports monarchs as well as other species. Using seed or plant sources with a variety of genotypes will ensure that floral resources remain available for longer periods of time, especially under drought (Genung et al., 2010). Ensure that seed is collected from multiple patches in a seed collection zone to increase genotypic diversity.

If local milkweed plant materials are not available, it may be necessary to collect seed from local milkweed populations to directly seed into a site or provide to a commercial producer to increase plant materials for restoration purposes. As a rule, collect no more than 20% of available seed for any species per year (Eckberg et al., 2016).

Establishing Milkweed and Nectar Plants

Water and Irrigation

If feasible, water or irrigate milkweed and nectar plantings during the first year to increase survivorship of plants. This is particularly important in arid regions and for supporting the establishment of container plants. Seeded plantings in many regions will not need irrigation.

- If possible, take advantage of high precipitation years to plant milkweed: higher precipitation has been linked to higher survivorship of milkweed plants in restoration projects (Bowles et al., 2001).
- Potential irrigation systems include deep pipe and porous hose irrigation systems that are low maintenance and increase planting survival, especially in arid environments (Bainbridge,

2002; Bainbridge 2012). Drip irrigation on a timer, with emitters placed near the base of the transplants, delivers water efficiently to target plants.

- Consider mulching transplants to retain moisture—do not mulch habitat plantings that were started from seed.
- In arid regions, plant or seed in climactic microsites that will retain moisture longer into the summer, such as north-facing slopes or gullies that will retain snow or water.

Interseeding

In some areas, interseeding can be used to increase the diversity and abundance of floral and host plant resources for monarchs. This may be appropriate for areas that have been subject to overutilization by livestock grazing, wildfire, long-term mowing, or other vegetation-altering management or natural disturbances that over time have reduced the diversity of the plant community or exhausted the seed bank of native forbs. Interseeding is a way to fill in bloom gaps; for example, if an area has few fall-blooming plants, interseeding a seed mix with fall-blooming plants will increase the value of that area for nectaring monarch butterflies and other pollinators.

Successful interseeding relies on disturbance (for example, seeding using a seed drill and drag harrows or into herbicide bands). Disturbance before seeding suppresses the existing vegetation and gives seeds a better chance of bare soil contact and germination; disturbance after seeding helps suppress dominant vegetation and helps seedlings establish. The amount of suppression required depends on the existing vegetation. Invasive plants and introduced cool-season grasses are often difficult to interseed into because they are generally difficult to suppress, while interseeded species can more readily establish into native warm-season or mixed-season grasses. Interseeding can be low maintenance and successful under certain circumstances but still requires thoughtful management. Stochastic factors can influence the outcome (as with every restoration), especially soil moisture and precipitation in arid climates. See Appendix C for interseeding resources.

Milkweeds

Milkweed seeds often require specific stratification, soils, and temperatures to germinate, and reported germination rates can sometimes be as low as 5% (Landis, 2014). See Appendix C for resources. In arid landscapes such as the Central Valley of California, establishment can be particularly challenging. Although more research is needed to identify the best techniques for establishing milkweed in the arid areas, following are some suggestions for increasing success.

Transplants

- May have better success than seeding.
- Larger plants may be more likely to establish because of deeper root development.
- Irrigation will improve establishment, especially if winter rainfall is below average.
- In climates with mild winters, getting transplants in the ground in the fall or early winter (October–December) is generally best. In climates with cold winters, the optimal time for transplanting is in late fall, late spring, or early summer (March–May). Summer planting may be successful if irrigation is available.

Seeding

- Success rate usually not as high as transplants but can be useful under certain conditions.
- Some species and genotypes require or benefit from 2–6 weeks of cold stratification before germination (see Kaye et al., 2018); sowing seeds outdoors in the fall or early winter is recommended to increase germination success the following spring.
- Intensive site preparation is essential. Milkweed seedlings do not compete well against weeds and existing vegetation, so consider solarizing, herbicide, or a similar site preparation technique to remove vegetation a season or two in advance.
- Include milkweed seed at realistic rates in mixes to ensure some establishment (at least 1–5% ideally).
- During the establishment phase, control weeds through mowing or targeted or selective herbicide applications again in the early spring (February–April) before milkweed germinates if weed pressure is high.

Rootstock

- Limited commercial availability, but it can be harvested and saved locally from cultivated populations.
- Flag milkweed during growing season; then selectively dig up rootstock during dormant season, cutting into ~4-inch chunks for replanting elsewhere immediately. If it is not possible to transplant rootstock immediately, store rootstock in moisture-proof containers in cool conditions until outplanting.
- Irrigate if necessary during the establishment phase.

It is best to manage for and restore habitat with varying densities of milkweed (Stenoien et al., 2018)—smaller, less dense patches are preferred over isolated plants or large, dense stands of milkweed. In addition, interspersing small patches of milkweed into a more diverse wildflower planting (as opposed to mixing the milkweed seed into a diverse seed mix) may increase milkweed establishment success, because milkweeds may not compete well with other planted wildflowers. The goal is to support a diverse, heterogeneous native plant community rather than a milkweed monoculture.

Nectar Plants

Native nectar plants vary in germination and propagation requirements. Due to this variation, it is difficult to prescribe a one-size-fits-all seeding time or strategy for a single region. Native seeds with specific germination requirements may need to be treated prior to direct seeding or be seeded separately. Consult regional botanists or plant material specialists to determine optimal seeding times based on the species, your region, and climate conditions. In areas with mild winters and hot, dry summers, generally aim to plant seeds in the fall or winter, or spring or fall when planting perennial plants as plugs or container materials. For areas with cold winters, seeding in the spring or fall is recommended. When planting perennial plants as plugs or container materials, generally aim to plant in the spring or late summer.

Revegetation Post-Wildfire

- In addition to soil stabilization, ensure that adequate floral resources are provided after a wildfire by seeding quick-growing, ideally native, annual or perennial flowering plants.
- Avoid seeding only yarrow (*Achillea millefolium*) and flax (*Linum lewisii*). Although these widely used post-fire restoration and rehabilitation species may be important components of a seed mix to initially establish native vegetation due to their ability to establish quickly and suppress nonnative plant invasion, they attract few pollinators, cannot support a diverse pollinator community (Cane and Love, 2016), and are not monarch nectar plants.
- Establish corridors or high-density plantings. Restore habitat connectivity in the post-fire landscape. Focus seeding or planting efforts to connect remaining intact/unburnt habitat. Plant or seed in high-density corridors or patches to provide connectivity and serve as "stepping stones" (Stanturf et al., 2014).
- Consider the appropriate seeding method for the site. Aerial seeding at low-elevation sites in the arid West is generally ineffective at establishing native plants (Knutson et al., 2014; Pyke et al., 2017); using a seed drill or planting bare-root perennial plants may be more cost effective. Seeding in high-elevation sites is likely to be the most successful and cost-effective use of resources.
- Reduce or eliminate the use of nonnative grasses in post-fire rehabilitation seed mixes and instead use native grasses and forbs.
- Be mindful of the potential for post-fire invasion, and prioritize where to use resources for invasive control and where to use resources for reseeding an area.

Restoration in Agricultural Areas

Agricultural areas include some of the most important breeding and migratory habitat for monarchs—including the Midwest, the Central Valley of California, and the Snake River Plain in Idaho. Although these areas are often highly modified from natural habitats, they also offer opportunities for restoration that will have a big impact on monarchs. Monarch-friendly plantings can be incorporated into hedgerows, orchard understories, pivot corners, crop margins, riparian buffer strips and corridors, or other out-of-production areas. And although it is always important to keep monarch habitat safe from pesticide exposure, it can be more of a challenge when creating monarch habitat in or adjacent to agricultural areas.

Detailed recommendations for monarch habitat restoration in agricultural landscapes is outside the scope of this report, but resources with guidelines can be found in Appendix C.

Pollinators Gardens in Urban or Suburban Areas

Although the greatest gains to monarch habitat conservation and restoration are found on the millions of acres of managed and natural lands, habitat creation in smaller spaces such as in urban or suburban areas can still play a very important role. Because monarchs are so mobile and wide-ranging, even small plantings of milkweed and flowering plants can offer resources to monarchs. Monarch "waystations" and pollinator plantings are becoming increasing popular at schools, businesses, and backyards throughout the country and offer benefits beyond just habitat. For electric power companies, creating gardens at corporate headquarters or other facilities can also provide an educational opportunity for staff and visitors to take a hands-on approach to monarch conservation. See Appendix C for resources.

Case Study: Nebraska Public Power District Restores Habitat for Monarchs

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Nebraska Public Power District (NPPD) and the Save Our Monarchs Foundation have joined together in an effort to provide a viable location to encourage the growth of the monarch butterfly and other invertebrates. NPPD has signed an agreement with the foundation to utilize approximately 50 acres of unused land west of its Beatrice Power Station to seed for milkweeds and other native flowering plants to help the monarch butterfly population grow.

"Nebraska sits in the heart of the monarch butterfly flyway and is a significant reproductive and migratory area for these iconic insects. Monarchs and other pollinators play a powerful role in the cycle of life that sustains us, while healthy, balanced ecosystems of native plants provide vital benefits to Nebraskans, from the clean water we drink to the clean air we breathe," said Randall Gilbert, Program Director for the Save Our Monarchs Foundation. "The willingness of NPPD to assist us is invaluable to our organization. Actions like these will help make a significant impact on the recovery of the monarch butterfly population."

Research findings from the monitoring of this and subsequent NPPD restoration sites will be compiled in order to share the methods, means, economic considerations, and environmental benefits of this project with other landowners and state agencies, with the goal of inspiring similar restoration efforts.

Figure 6-5
A before (left) and after (right) photo showing establishment of monarch habitat at the Beatrice Power Station near Beatrice, Nebraska.

Company Survey Results: Restoration and Revegetation

Extent Implemented: *Low*
Barriers: *Moderate-high*
Opportunity: *Moderate-high*

> *Due to financial and staff limitations, we generally won't be able to revegetate our areas with native milkweed plants, but partnerships with stakeholders could help us overcome that.*

Anonymous Company Survey response

For the specific revegetation questions included in the survey, implementation across asset types was relatively low. This does not necessarily mean that milkweed is not present on the properties that have undergone revegetation. Notable barriers included the following:

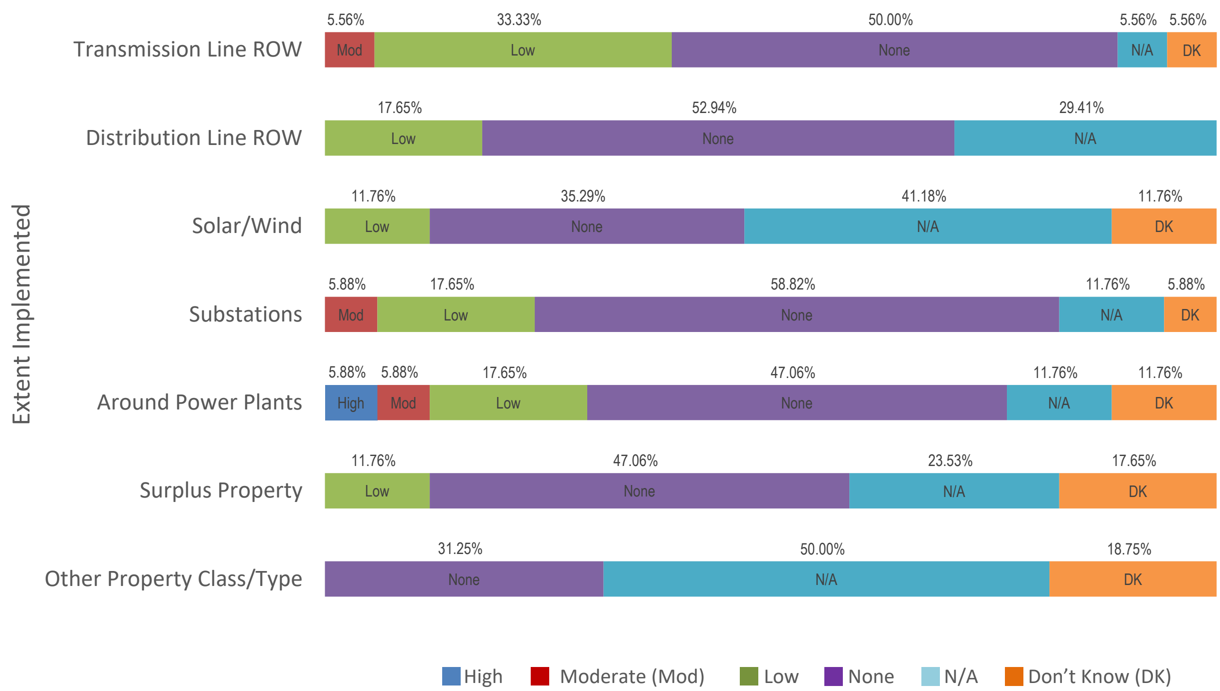
- Not having a management plan that calls for the revegetation actions specified
- Access to locally adopted seeds
- Lack of management or regulatory requirement
- Costs
- Opposition to rapid revegetation requirements in permits and for stormwater requirements
- Does not apply to gravel areas
- Solar panels are too low to accommodate
- Easements limit site control
- Concerns from ranchers and farmers
- Concern regarding the spread of the weeds into areas that need to be low growing (substations, solar sites)

Comments/Barriers: Restoration and Revegetation

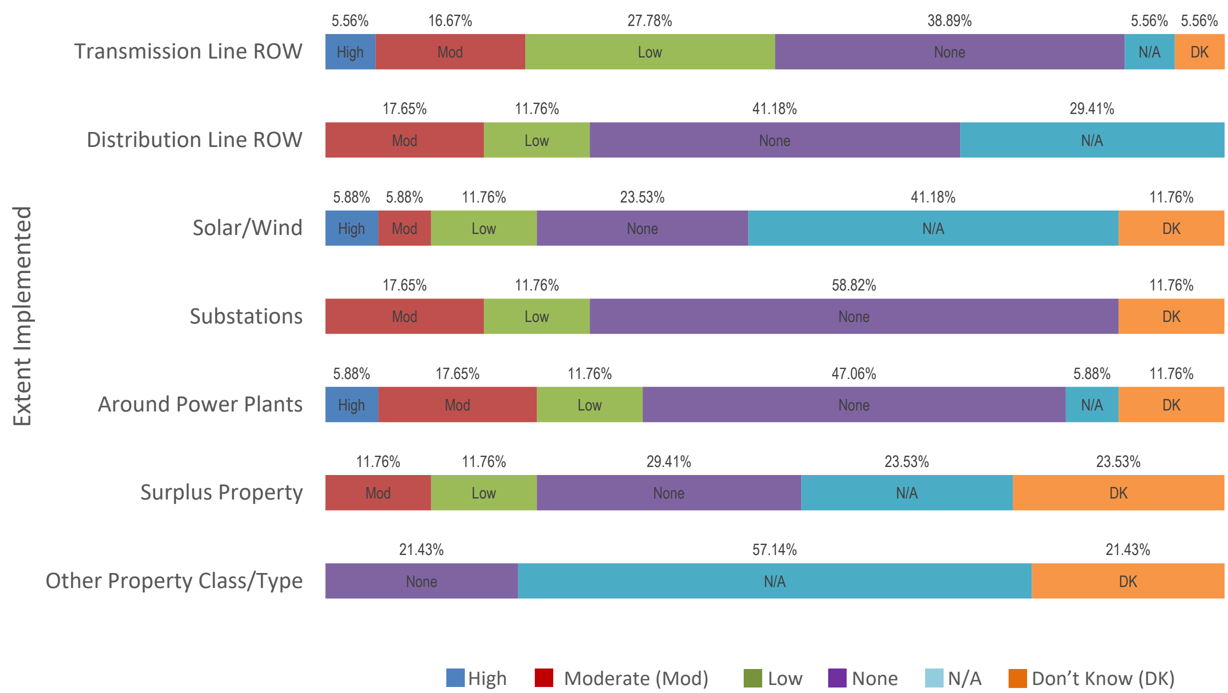
- Local restrictions and security issues generally prevent use of milkweed at substations.
- Currently no policy or plan to address the revegetation actions in this survey.
- For revegetation along transmission line ROWs and at substations, there is a lack of locally adapted native forb seed in some areas, higher cost of native species compared to erosion control seed mixes, and no internal or federal policy requiring revegetation with native plants.
- Not currently done but could be implemented in some areas.
- Barriers include costs and need to guarantee 70% vegetative coverage as soon as possible due to permit requirements.
- Currently, we only implement this action as required by state or federal agencies or by the property owner. Solar panel height, weed control, and use of herbicides prevent implementation at solar facilities. Pollinator vegetation is included in some power plant seed mixes; however, costs generally prohibit such a practice. Local restrictions and security issues generally prevent use at substations. Revegetation is typically not practiced on surplus properties.
- Cost and plant establishment are barriers. Currently done on a very limited, case-by-case basis when project permitting requires native species.
- Staff education and information; budget; gravel sites.
- Availability of seed and lack of consistent company-wide seeding specifications.

- Barriers include costs; currently, only implemented as required by state or federal agencies or by the property owner.
- All easement areas for our transmission lines; we don't have control beyond what is included in our IVM plan.
- Solar panel height, weed control, and use of herbicides prevent implementation at solar facilities. Milkweed is included in some power plant seed mixes; however, costs generally prohibit such a practice. Local restrictions and security issues generally prevent use at substations.
- Solar sites are managed by others.
- Stormwater runoff requirements requiring very rapid establishment of vegetation are barriers.
- No formal plan or methodology established. Training needed to implement change. However, I have seen native milkweed come up in transmission ROWs, but I don't believe it was planned in the seed mix.
- Not enough financial or staff resources to revegetate with milkweed species; partnerships in the future could be made with local stakeholder groups.

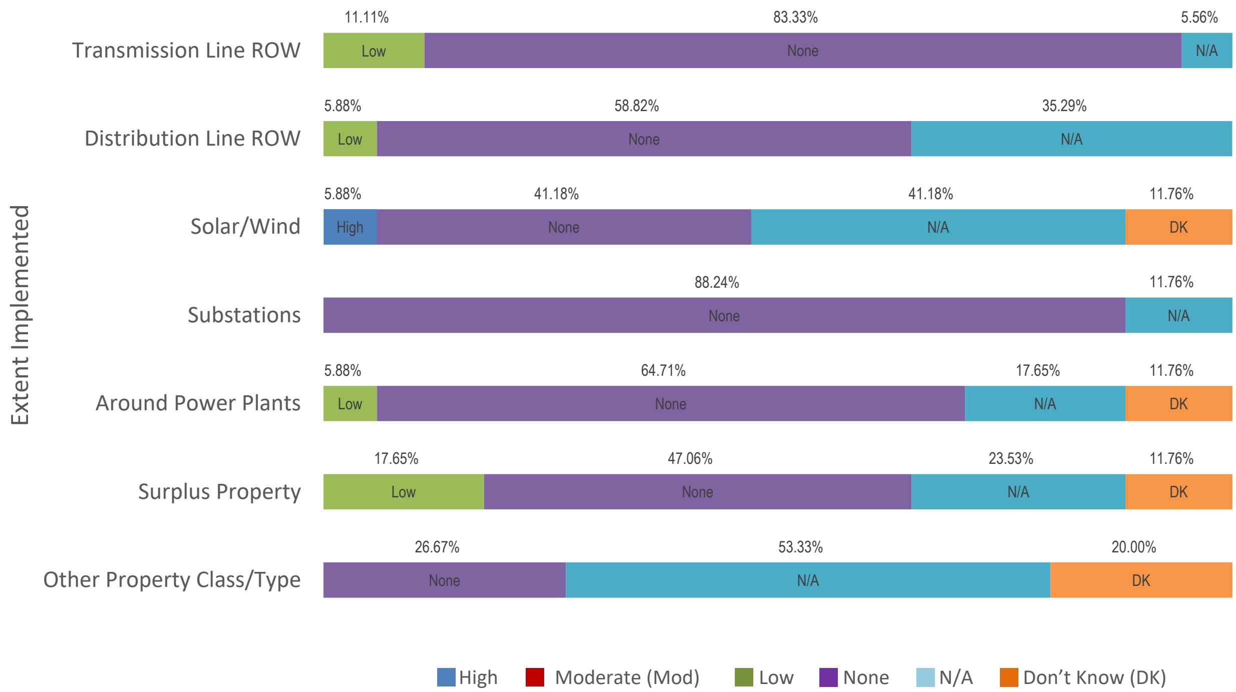
Revegetation: Include at minimum one native milkweed species (if habitat is appropriate) in revegetation projects.



Revegetation: Plant native, monarch-attractive nectar species that will provide floral resources throughout the breeding season, with a minimum of three species in bloom at any time between spring and fall.



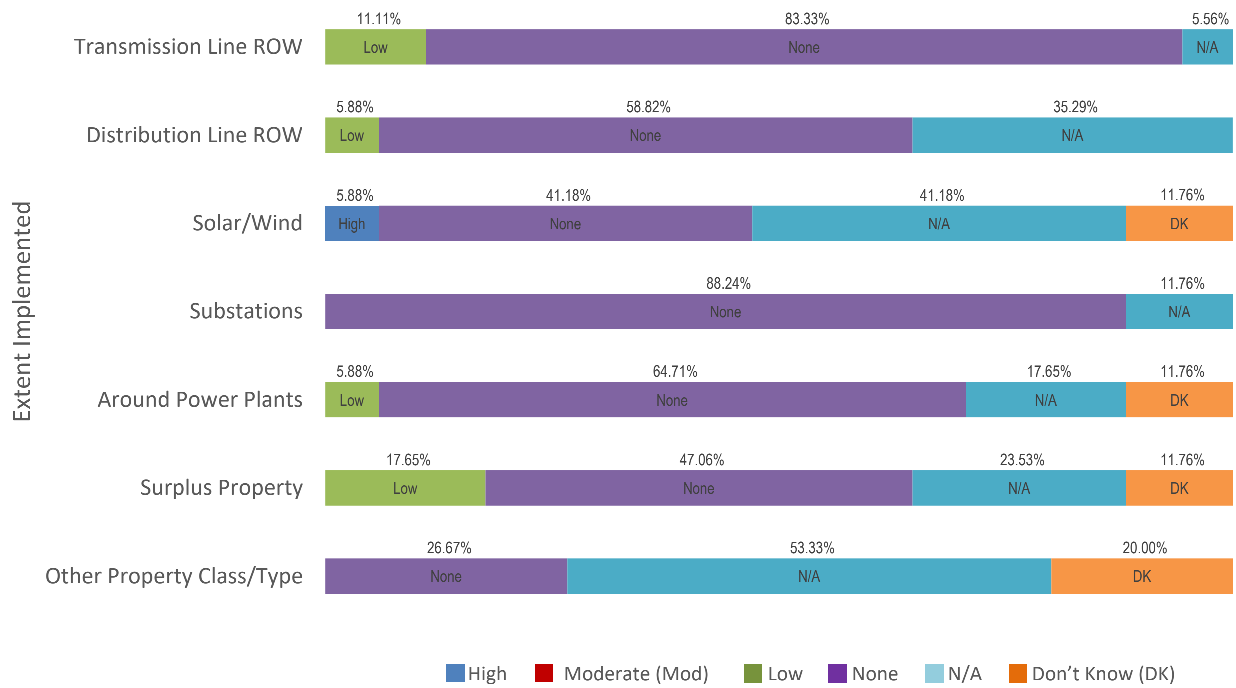
Revegetation: Interseed to improve diversity and abundance of nectar and/or milkweed species in existing stands of vegetation that have lost diversity.



Detailed Comments/Barriers

- We currently don't have a policy or program to address this issue.
- In our service territory, nonnative grasses would likely outcompete any interplanted areas without weeding and intensive management or spraying nonnative grass with grass-targeted herbicides. At substations, this hasn't been suggested as a strategy.
- Not enough financial or staff resources to revegetate with milkweed species, partnerships in the future could be made with local stakeholder groups.
- Not likely an option.
- Only known method would be drill seeding, which is too expensive; frost seeding could be done if proven to be an effective application; otherwise, just wasting seed.

Revegetation: Increase abundance of native milkweed and/or nectar species in seed mixes.



Detailed Comments/Barriers

- Revegetation is not always required, but where required, we use standard native seed mixes. There is no set requirement for the number of nectar species or milkweed species.
- Barriers: cost; seed availability; lack of consistent, company-wide seed specs.
- Not currently done but could be implemented in some areas.
- Barriers include costs; currently, only implemented as required by state or federal agencies or by the property owner and at some power plants and substations.
- Solar panel height, weed control, and use of herbicides prevent implementation at solar facilities.
- Milkweed and nectar species are included in some power plant seed mixes; however, costs generally prohibit such a practice—as does the need to achieve 70% vegetative coverage as quickly as possible.
- Local restrictions and security issues generally prevent use at substations.
- Vendors use industry standard seed mixes.

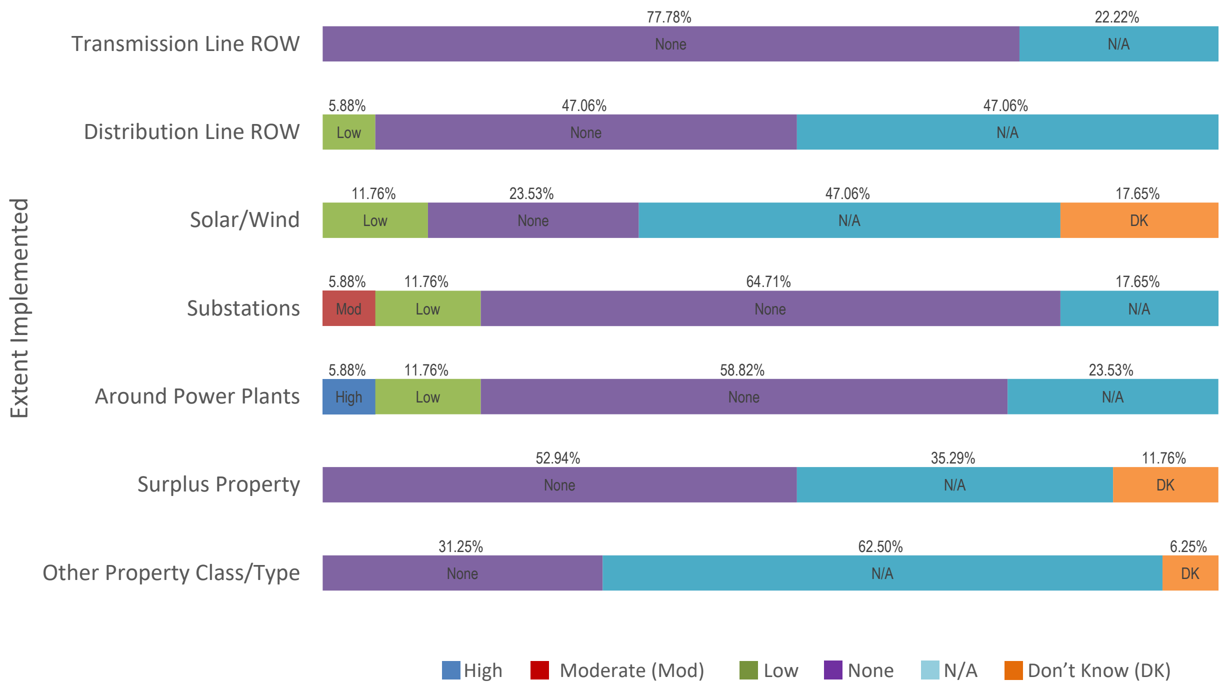
Case Study: American Electric Power Using Power Plant Site for Pollinators, Monarch, and Community Education

AEP has maintained the Eagle Watch Nature Trail near the Flint Creek Power Plant in Northwest Arkansas since 1999. The 65-acre site is open to the public for bird watching and includes a 2-acre prairie and pollinator garden. Terry Stanfill, a retired Flint Creek Plant employee, has managed the area to promote environmental education and support local wildlife, including pollinators and the monarch butterfly. He coordinates field trips and activities for local schools, Audubon clubs, and 4-H and Scouting groups. He works with the Gentry Fire Department to conduct annual burns of the prairie and has maintained the site's Wildlife Habitat Council Certification.

During 2018, Terry planted swamp milkweed plants on the property. It is estimated that Terry has connected with well over 200 individuals through pollinator-related field trips or the milkweed plant/seed donation, plus the approximately 1,500 people who visit the site on an annual basis. This outreach has had a large geographical impact, reaching parts of Northwest Arkansas and all of Benton and Washington Counties, as well as Delaware County in Northeast Oklahoma. Staff at the Flint Creek Plant will be planting a native-pollinator seed mix, which includes milkweed and other flowering forbs, on a total of 11 nearby acres. There are plans to expand this program if the seeding is successful. These efforts are in addition to mowing schedule changes that are being considered on other large areas of plant-owned property. The goal is to help protect pollinators while reducing mowing costs.

Figure 6-6
Monarch caterpillar on milkweed (left). Terry Stanfill helping lead a volunteer workday (right).

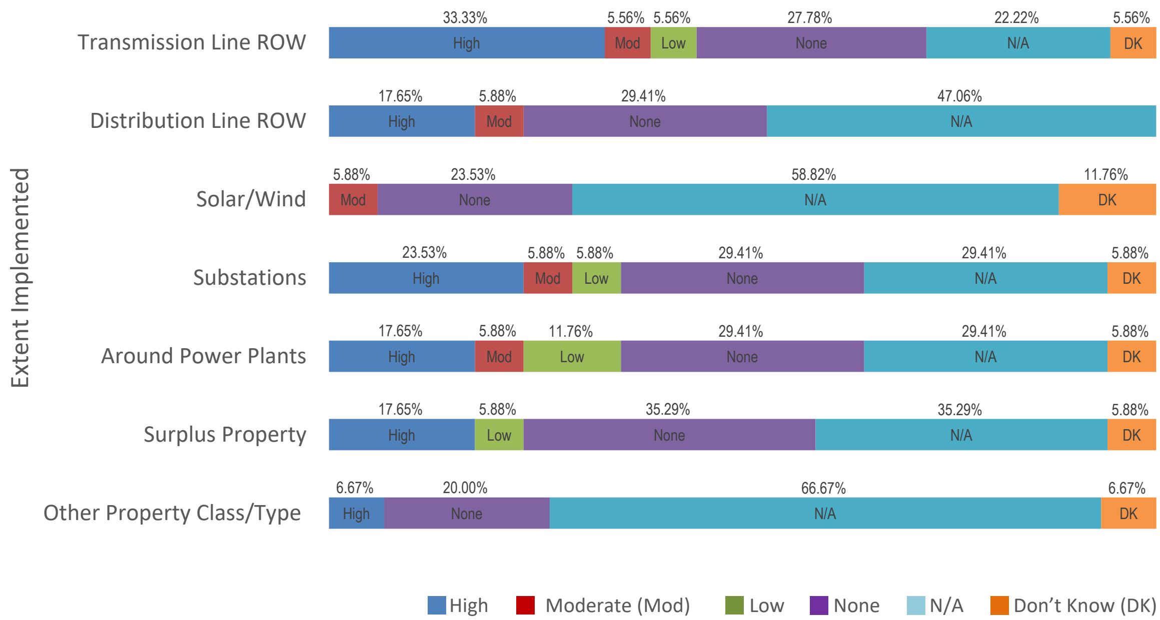
Revegetation: Irrigate for early plant establishment as needed (for example, in drought years, arid areas, for transplants, and so on).



Detailed Comments/Barriers

- For transmission line ROWs, it is considered too costly; most of our transmission lines are in remote locations without available water, and road systems may not be good enough for water trucks. For substations, some personnel believe that xeriscaping projects need minimal to no maintenance and that irrigation systems only need to be temporary (up to 2 years) and thereafter, plantings should not need additional water. Substation xeriscaping projects receive some irrigation, at least during the first 2 years, but it is sometimes not enough for plants to be established during drought years.
- No irrigation occurs on our ROWs.
- Irrigation isn't necessary in our area.
- New plantings at substations are irrigated, while turf/eco-lawn mixes are usually not. Cost and lack of installed irrigation infrastructure are barriers.
- Not possible.
- Irrigation is practiced at some facilities as needed to establish vegetation. Barriers include a local water supply at remote sites.

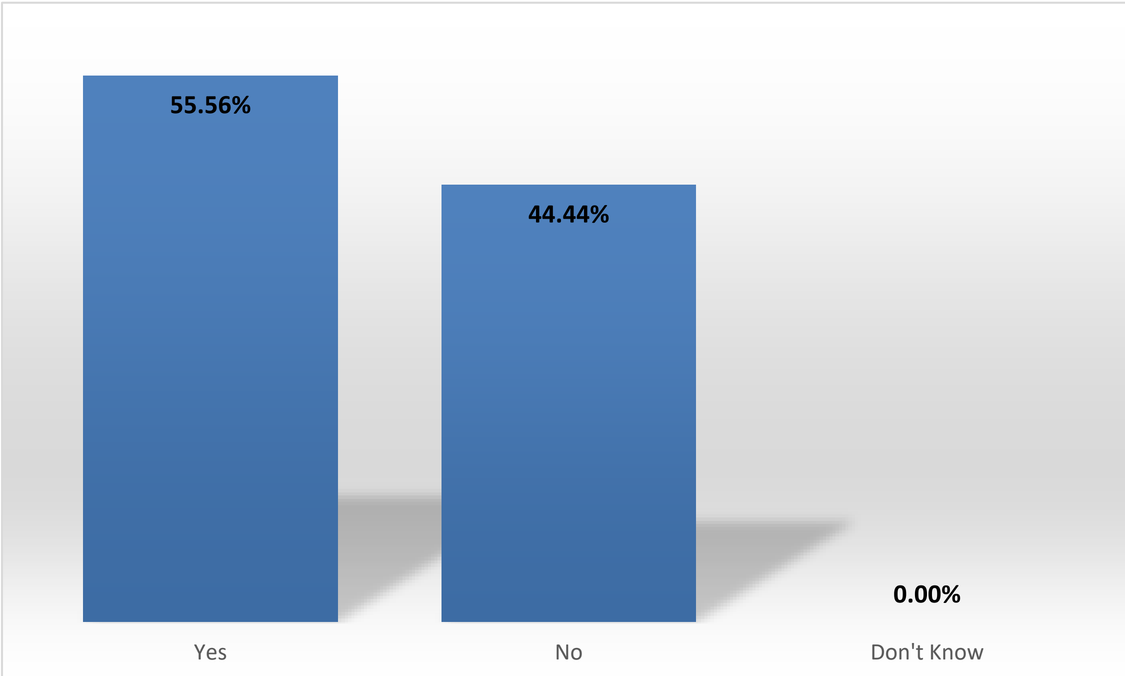
Revegetation: Minimize soil disturbance (disking, tilling) during restoration activities to avoid spreading invasive plants.



Detailed Comments/Barriers

- We don’t have a policy or program to address this issue.
- Soils sometimes need decompacting before seeding and planting.
- No restoration activities or revegetation occurs as part of our IVMP. We generally don’t remove large swaths of forest and only selectively remove plants, which doesn’t require restorative efforts.
- High rating for transmission and distribution ROWs as this applies to vegetation management and restoration guidelines, which specifically recommend minimization of soil disturbance. Restoration guidelines for some power plants specifically recommend minimization of soil disturbance.

Have you proactively undertaken measures to conserve monarch butterflies or provide monarch-friendly pollinator habitat (for example, altered management practices to enhance habitat or installed new monarch habitat)?

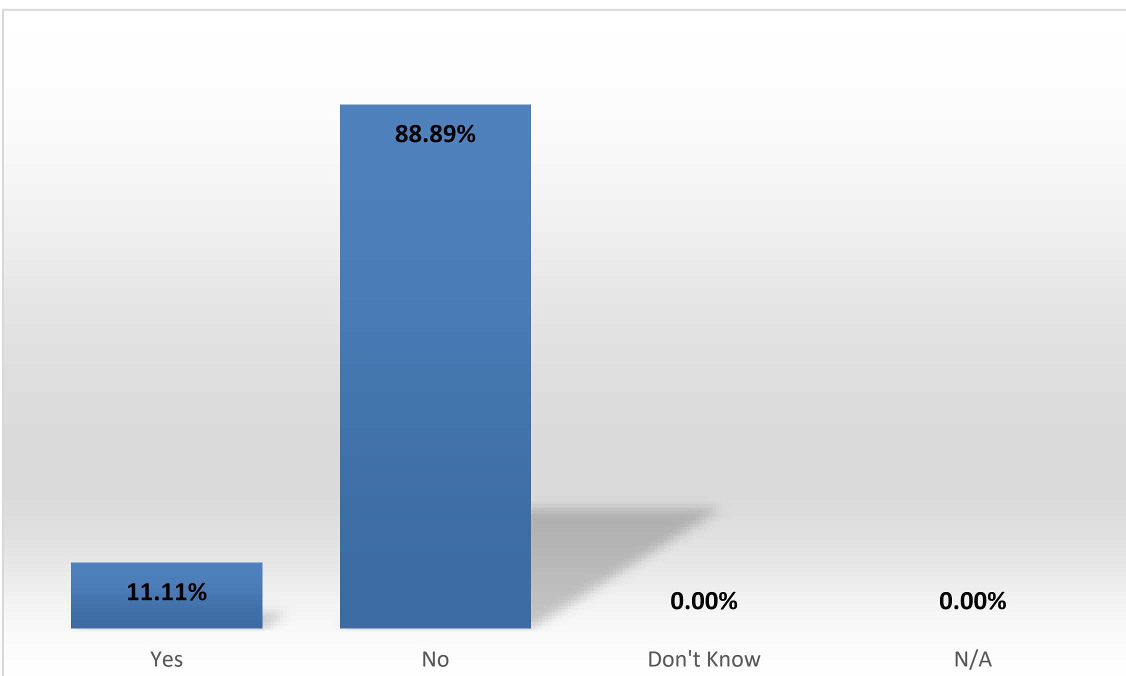


Detailed Comments/Barriers

- IVM efforts are focused on promoting pollinator and monarch habitat. Partnership includes a pollinator/rain garden and a large ROW restoration project focused on creating high-quality pollinator and monarch habitat. Restoration after new projects includes pollinator-friendly seed mixes where appropriate. We planted a large pollinator garden at our X Generating Station. ROW within the X Generating Station was planted with a pollinator seed mix.
- At the moment, we have not proactively undertaken measures to conserve habitat; however, it is something that we are internally looking into—whether that is partnering with nonprofits or other stakeholder groups.
- Added pollinator habitat to gas transmission pipeline projects and handed out milkweed seed packets at company events.
- We have partnered extensively with the Wildlife Habitat Council to create monarch-friendly pollinator habitat or “monarch waystations” at 38 different certified sites. These include pollinator gardens, prairies, rain gardens, and “no-mow” areas.
- Limited efforts have been made to provide monarch butterfly habitat—such as transmission research plots, power plant pond closures, final landfill cover, some surplus properties, where incidental vegetation growth supports the butterfly, and state or federally required mitigation sites (that is, wetland and riparian habitats). Some projects were done in collaboration with nonprofits; for example, projects have been done with a local arboretum, the State Department of Natural Resources, and several groups such as the State Game and Fish Commission near the X Plant.

- Various restoration collaborations at corporate ROWs and other facilities: 1) teamed up with the National Wild Turkey Federation to plant 3,000 acres of pollinator habitat; 2) teamed up with [corporate] to plant several pilot pollinator habitat projects (5 acres) on ROWs; 3) planted several substations (3 acres) in two states with pollinator habitat (collaboration with agencies); 4) planted common milkweed at several ROWs and adjacent lands (State Agency collaboration); 5) planted pollinator habitat at several solar farms (5 acres) (no collaboration; internal projects); 6) enhanced and planted pollinator habitat at several generation facilities (10 acres).
- Maintain pollinator habitat using IVM practices.
- We took 48 acres of surplus property near one of our power plants (not related to its operation) and installed new pollinator/monarch habitat. We worked with a nonprofit called *Save Our Monarchs*. With Save Our Monarchs, we spot-sprayed herbicides and planted milkweed under portions of transmission ROW that we own to promote pollinator habitat (5–10 acres). With Save Our Monarchs, improved pollinator habitat on surplus property (5–10 acres). Improved pollinator habitat on our owned transmission ROW (1–5 acres).
- Through the practice of IVM on our transmission ROWs, we have created a low-growing plant community that is beneficial to pollinators, including monarchs. Also, have begun to establish some pollinator/wildflower plots on properties where mowing is not feasible.
- Natural Resources Management has implemented management actions at a few locations to enhance pollinator habitat on our public lands on some of the dam reservations and transmission line ROWs. The pollinator seed mix included plants that are monarch-friendly.

Do you have an Integrated Vegetation Management (IVM) objective specifically to support monarchs?



Detailed Comments

- Current focus is on all pollinator species, not just monarch.
- The pollinator BMPs we are developing will likely address milkweed populations.
- Not at this time but could be something for the future.
- Active IVM program with early succession habitat as one of the goals but no IVM objective specifically targeted to monarchs and monarch habitat.
- Promote a low-growing plant community with a focus on pollinators.
- Currently there is not a specific IVM objective related to monarchs. We focus on pollinators.

Monitoring

Scientific and Expert Summary: Monitoring

Comprehensive monitoring information on private and public lands for monarchs and milkweed is lacking across most of the country, but there are various efforts (see below) underway to improve monitoring. Monitoring is a crucial part of identifying where monarch habitat exists on power company properties in order for it to be protected and managed to support monarchs. As noted in the Priority Areas for Habitat Conservation and Restoration section of this report, monarch breeding and migratory habitat is widespread in the lower 48 states and southern Canada. Implementing supportive practices, such as mowing outside of the monarch breeding window, may be difficult over the monarchs' entire range; understanding specifically where monarch habitat occurs on your property allows conservation actions to be implemented most effectively and in areas with the highest value as monarch habitat.

Monitoring is particularly important to understand where *existing* habitat is located to ensure its proper management and protection.

The level of effort needed to confirm site-specific habitat quality on electric power company property can range from minimal (for example, presence of milkweed) to extensive (for example, abundance and quality of milkweed and nectar resources; monarch adult and juvenile presence) depending on monitoring goals. For example, monitoring for milkweeds must be done through vegetation surveys during the growing season, with the survey timing varying by milkweed species' phenology and location, as well as the weather in that year. Monitoring for adult butterfly presence entails visual surveys and must be done in favorable weather conditions at appropriate times of the year based on location. Monitoring for immature life stages (egg, caterpillar, and chrysalis) is necessary to document whether an area is supporting breeding, but this monitoring is often more time- and labor-intensive and must be completed at specific times of the year when monarchs are likely to be breeding in the area. An additional caveat is that monarchs may not use habitat for breeding during a portion of a season or at all in a season some years; they may occupy the site for the entire season in other years. For this reason, areas that have milkweed and adult butterflies present are often assumed to be breeding habitat.

- ***The majority of experts surveyed said that the minimum evidence or information they would need to determine whether a power company's property is supporting monarch habitat is field monitoring on the property. They also identified that high-priority information to collect is milkweed presence/absence and adult monarch presence.***

Although monitoring is ideally completed on a site-specific basis, additional tools can be used to identify broad areas that are most likely to contain high-quality monarch habitat from a "birds-eye" view and not require fieldwork. These tools include models, such as the habitat suitability models developed for the western United States (Dilts et al., 2018) and the models in development for roadsides nationwide (see Monarch Joint Venture's website https://monarchjointventure.org/ for more information). Other tools that can be employed include existing records with high geo-spatial accuracy of monarch and milkweed occurrences (for example, Integrated Monarch Monitoring Program; Western Monarch Milkweed Mapper). National or regional land cover data sets (for example, USGS National Land Cover Database) or local, pre-existing habitat inventories may also be useful because some habitat types are more suitable for monarchs and milkweeds than others. For example, a growing body of research (for example, Thogmartin et al., 2017a; Zaya et al., 2017; Dilts et al., 2018) shows that, generally, dense forests, high-elevation areas, and open water are unlikely to host milkweeds; shrub-steppe habitats may host moderate levels of milkweed; and grasslands and edges of agricultural lands and wetlands often host the highest levels of milkweed.

Although developing a comprehensive monitoring program to identify monarch habitat on electric power company properties is outside the scope of this report, see the Summary for discussion of future research opportunities.

Major monitoring programs for monarchs and milkweeds include the following:

- Monarch Conservation Database developed by the U.S. Fish and Wildlife Service: Database to track on-the-ground conservation actions for monarchs nationwide. The database aims to capture information about recently completed, ongoing, and planned conservation efforts for monarchs, such as improving and creating habitat by enhancing milkweed and blooming nectar plant resources. The database will help the U.S. Fish and Wildlife Service assess and quantify conservation actions taken on behalf of monarchs across the United States.
- Integrated Monarch Monitoring Program uses protocol-based surveys for milkweed, nectar resources, and adult and immature monarchs to monitor monarch populations in Canada, the United States, and Mexico. This new monitoring program is an initiative designed by the Monarch Conservation Science Partnership and led by the Monarch Joint Venture to monitor monarch populations and habitat throughout their breeding range. Training events and protocols are available on the MJV website. Data gathered through this effort are used to inform local, regional, national, and international conservation efforts.

- Monarch Larva Monitoring Project uses protocol-based surveys for milkweed and immature monarchs to monitor in the United States and Canada. This is a citizen science project of the Monarch Joint Venture and University of Wisconsin Arboretum (previously a program of the University of Minnesota Monarch Lab). Volunteers monitor milkweed stands weekly to count monarch eggs, larvae, and pupae to better understand how and why monarch populations vary in time and space. Data collected from this effort have been used to determine the phenology of breeding in different areas, survivorship rates from egg to fifth instar larvae, year-to-year and site-to-site changes in monarch densities, the number of monarchs produced (on average) by a milkweed plant, and rates of parasitism.
- Journey North collects opportunistic observations of milkweed and adult and immature monarchs to better understand monarch phenology. Participants report observations of migrating monarchs to real-time migration maps. These maps also track first emergence of milkweeds, first monarch eggs, and first monarch larvae across the country.
- Xerces' Western Monarch Milkweed Mapper collects opportunistic observations of milkweed, nectar resources, and adult and immature monarchs in the western United States. This project is part of a collaborative effort to map and better understand monarch and milkweed occurrence across the West. Data contributed to the Mapper will improve the understanding of the distribution and phenology of monarchs and milkweeds, identify important breeding areas, and help to better understand monarch conservation needs. It also collects data on nectar plants used by monarchs. Partners include Xerces, U.S. Fish and Wildlife Service, the Idaho Department of Fish and Game, and the Washington Department of Fish and Wildlife.
- Xerces' Western Monarch Thanksgiving Count uses protocol-based monitoring of the monarch overwintering sites along the Pacific coast in California and Baja, Mexico. This project is a large citizen science effort coordinated by Xerces and one of the Count's founders, Mia Monroe, to track the overwintering population. Butterfly counts are conducted during pre-defined windows around Thanksgiving and New Year's. Additional goals include conducting habitat assessments and mapping of groves.

Case Study: New York Power Authority Monitors for Monarchs and Bees

The New York Power Authority (NYPA) has been officially re-accredited as a "Right-of-Way Steward" by the Right-of-Way Stewardship Council for sustainable integrated vegetation management on its electric transmission right-of-way systems. NYPA manages 1,400 miles of transmission right-of-way corridors. As part of NYPA's Integrated Vegetation Management (IVM) program, NYPA has initiated two separate surveys to verify the existence of pollinators and associated habitat on its transmission rights-of-way.

In 2016, NYPA's vegetation inventory program began mapping areas occupied by milkweed populations as they are found existing in the right-of-way. After training of the field crew, NYPA mapped what they came across or could find with a rapid scan of the appropriate polygon. The potential size trigger would be a patch of one or more of the species covering at least 10 feet by 10 feet. Attributes include survey date, presence/absence of the three milkweed species (common, swamp, butterfly), acres, comments, and creator. The vegetation inventory is completed on one quarter of the system each year; therefore, in 2019 NYPA will have completed this milkweed population mapping across the whole transmission system.

In addition, in 2018 NYPA began to collect broader pollinator data in the form of a bee survey along the ROW. NYPA worked with the Pollinator Partnership to train field staff on basic bee identification skills. The overall goal was to confirm that the vegetation management program aligned with the New York State Pollinator Protection Plan and the Federal Pollinator Action Plan. NYPA intends to use data to determine which bee groups are pollinating plants and living along the ROW corridor. All survey data collected will be recorded in the field computer in the NYPA pollinator database. By 2021, the bee survey will be complete across all NYPA's transmission system from 180 sample sites. Both the monarch and bee surveys will be able to show the extent of habitat and pollinator use along the well-maintained right-of-way corridors.

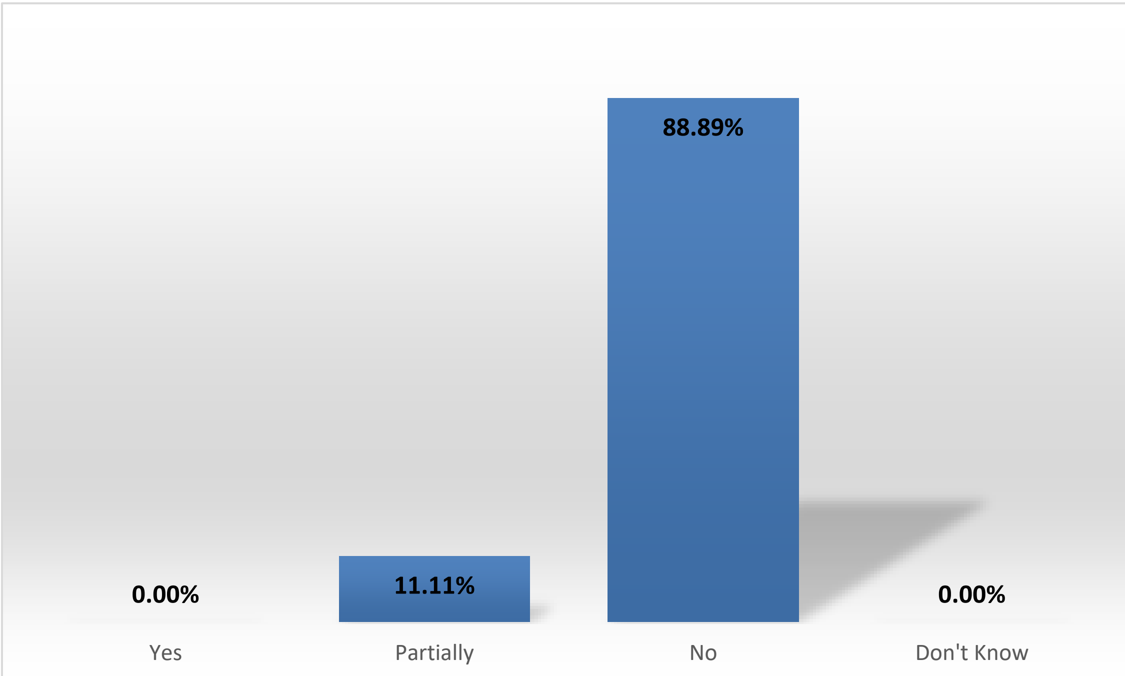
Figure 6-7
Milkweed (left) and monarch (right) under NYPA transmission lines

Company Survey Results: Monitoring

Extent Implemented: *Low*
Barriers: *High*
Opportunity: *Moderate-high*

As noted in this report, experts note the importance of knowing milkweed and monarch butterfly presence information for sites. However, the extent to which power companies report monitoring for monarch-friendly habitat is low and barriers are known to be high (primarily costs and time).

Have you estimated the extent of current monarch-friendly habitat within your managed property, whether proactively installed, existing, or otherwise? (*Monarch-friendly* means native milkweeds that provide food for monarch caterpillars and nectar for adults and/or flowers that provide nectar for adults—ideally a diversity of native species with overlapping flowering phenologies throughout the growing season.)



Education, Training, and Outreach

Scientific and Expert Summary: Education, Training, and Outreach

Successful monarch conservation, like most wildlife conservation, requires awareness of the species' needs and how to help contribute to its conservation. Education, training, and outreach to staff, contractors, property owners, shareholders, and the general public by electric power companies about monarchs helps create general awareness and train field staff to identify habitat.

- ***All experts surveyed identified education, outreach, and coordination activities as beneficial to monarch conservation, including the following actions.***
- Training managers, staff, and/or contractors to identify and protect milkweed and important nectar plants.
- Increasing communication and coordination with private landowners within ROWs about protecting monarch habitat.
- Performing outreach to the public, shareholders, and/or customers about the importance of monarch conservation.

Company Survey Response: Education, Training, and Outreach

Extent Implemented: *Low*
Barriers: *Low*
Opportunity: *High*

Overall, education, training, and outreach regarding monarchs specifically has been low. Barriers noted across survey questions included costs, lack of corporate priority to execute, and difficulty training contractors who have high turnover rates. However, companies are also showing interest in broader communication and education opportunities, indicating that these are currently being considered and/or starting up. Relative to the other conservation actions described in this study, this is one that has relatively low barriers to further implementation with a high opportunity.

Case Study: EPRI Power-in-Pollinators National Pollinator Week

In 2018, EPRI supported the funders of the Power-in-Pollinators Initiative to participate in National Pollinator Week (June 18–24, 2018). National Pollinator Week was initiated in 2008 by Pollinator Partnership, a nonprofit organization dedicated to promoting the health of pollinators. National Pollinator Week is now endorsed by all 50 state governors, with support from federal agencies, environmental groups, and private industry. It is a time to celebrate pollinators and spread the word about what individuals and organizations can do to protect them.

Fifteen companies actively participated, only one of which had celebrated National Pollinator Week previously. Being the first year of the effort for all but one of the companies, it was important to implement activities that were relatively easy to accomplish to help ensure positive experiences. Activities could be as simple as including an article in a monthly employee newsletter or as complex as hosting customer-facing plantings. Because a key purpose of the week is to educate, communicate, and spread the word about the importance of pollinators, most of the activities were designed to be highly people-facing—and EPRI tracked success using a "people reached" metric.

Collectively, the group reached an audience of **685,207 people** through social media, press releases, company bulletins and newsletters, volunteer efforts at local schools and wildlife centers, and a myriad of other creative and impactful outreach efforts. Companies gained new social media "followers" that they attribute directly to their communication during National Pollinator Week. One company gained an impressive 610 new followers during the EPRI-coordinated social media communication campaign.

EPRI plans to continue to coordinate participation in National Pollinator Week for the funders of the Power-in-Pollinators Initiative, the largest collaboration in North America helping electric power companies consider their relationship to pollinators. See EPRI report #3002014868 for 13 company success stories.

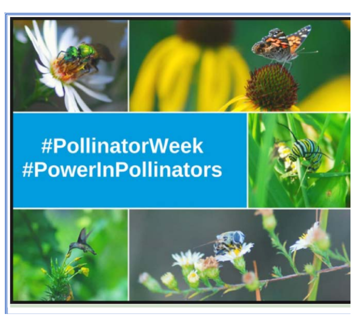
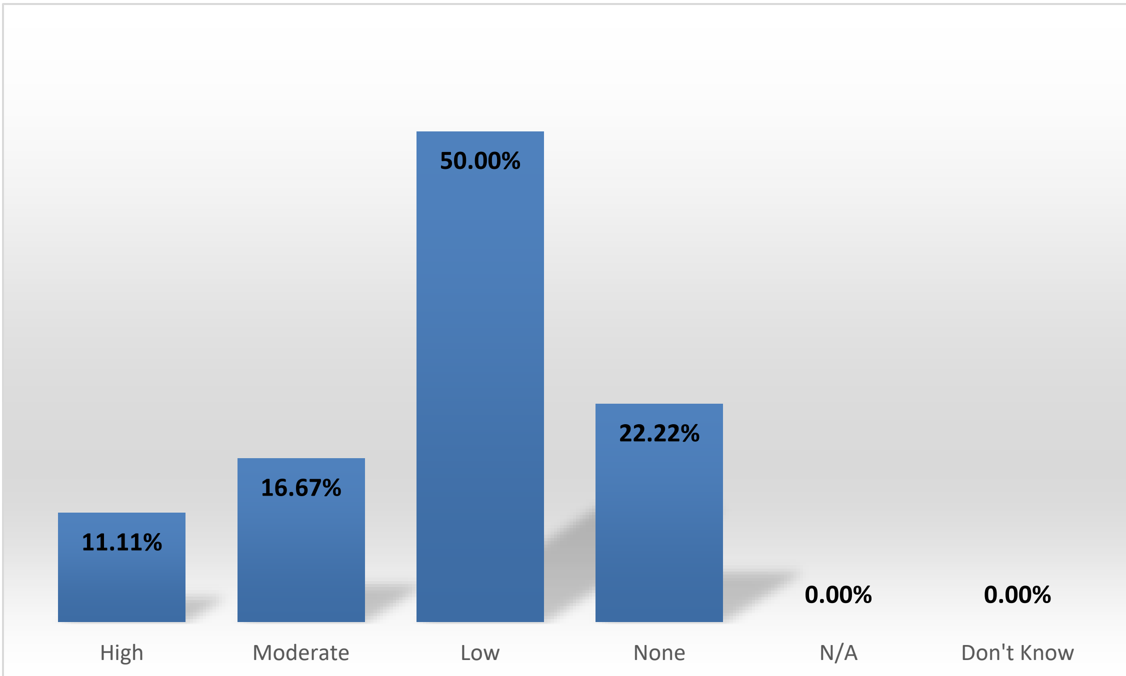


Figure 6-8
Posting to Twitter #powerinpollinators, June 20, 2018

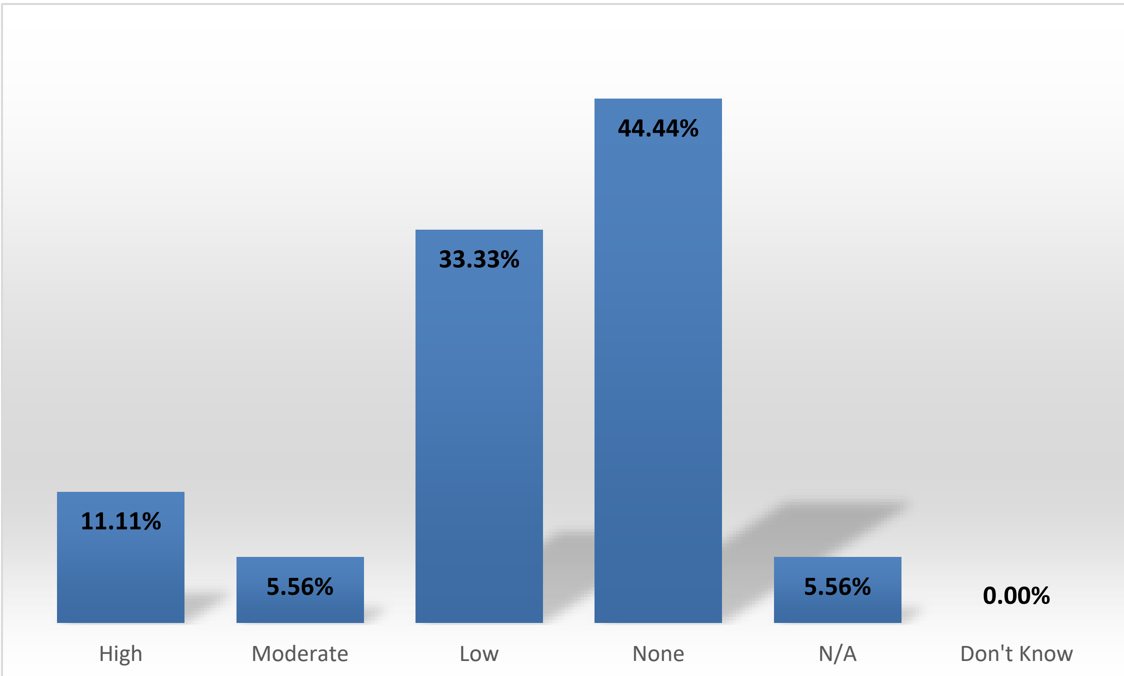
Engage the public about the importance of monarch conservation through interpretive signage at monarch habitat, online forums, social media posts, printed publications, workshops or events, and so on. Include information on your website about steps your company is taking to support monarch habitat.



Detailed Comments/Barriers

- Awareness of pollinator BMPs is currently being explored. It's possible that there may be some public outreach that focuses on monarchs in the upcoming years, but there would likely need to be a company project with impacts on monarchs and their habitat to provide the nexus between the impact and the mitigation that would enable spending on monarch-related mitigation.
- There is no active public communication with this topic at the moment. Barriers include financial resources, lack of public awareness, and a "hands off" approach to ROW management where we generally leave the land in a natural state.
- Financial constraints.
- No real barriers, but there is a concern that if many landowners want to restrict herbicide use and mowing practices, it will become much more expensive to maintain the ROWs. Social media engagement within the company has increased in recent months.
- It's hard to find public interest in our hosted events. But events where we've partnered with learning centers have been much better received. Information on those projects is also on the company website, listed under pollinators.
- Staff training, costs, resources.
- We are implementing pollinator habitat enhancement projects on some public lands and, where the public might encounter an area (trail or other rec area), we install signage.

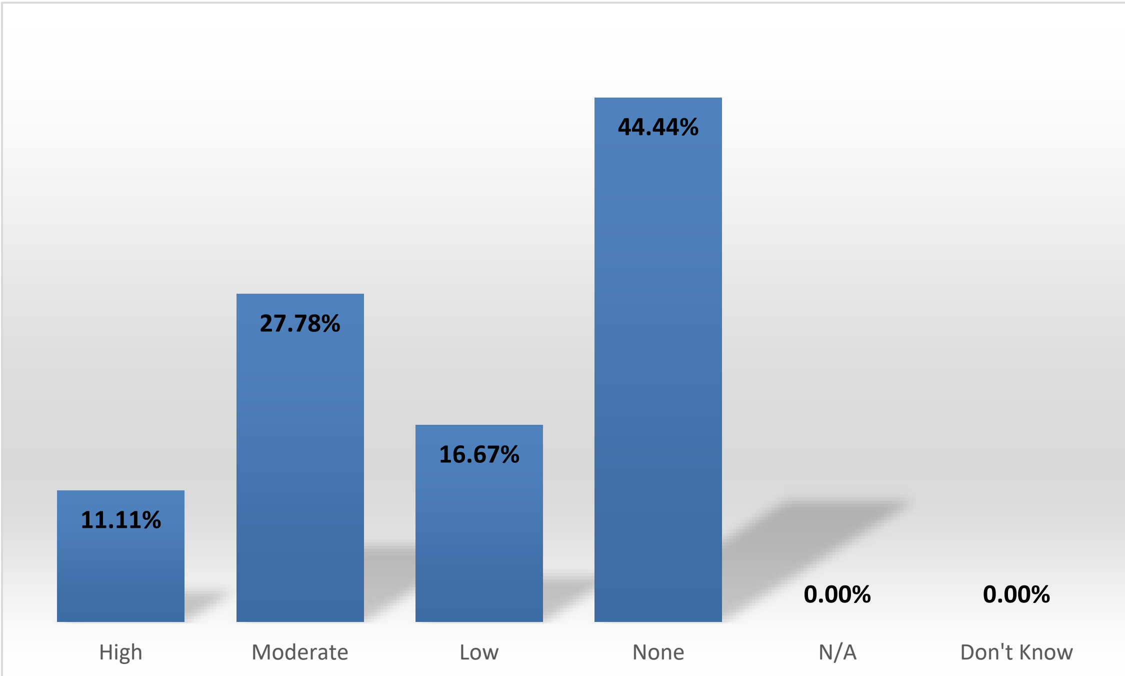
Communication/coordination with neighbors and landowners within ROWs about pesticide use and habitat protection and management. For example, produce and distribute outreach materials; contact larger landowners through e-mail or phone about conserving monarch habitat.



Detailed Comments/Barriers

- Landowners sometimes don’t contact us to inquire about ROW management activities.
- Staff training and budget.
- Costs—there is a concern that if many landowners want to restrict herbicide use and mowing practices, it will become much more expensive to maintain the ROWs. However, we have initiated an effort to use regionally appropriate native seed mixes on all new transmission construction projects. The implementation of this program, which may include pollinator vegetation, will include landowner engagement.
- Company does only direct contact with the landowner.
- As a utility, we use more herbicide on the property than the property owner does on average.
- We communicate through mailings to residents for any activities we do that the public might have interest in.

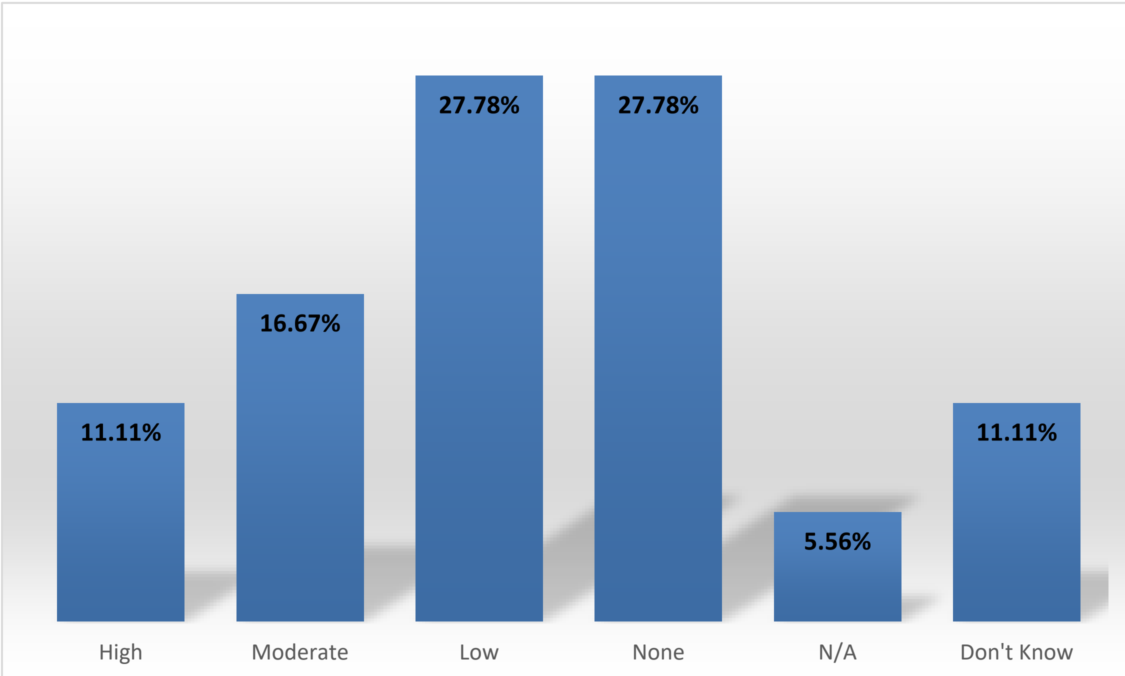
Train staff and contractors in plant identification. The ability to recognize native plants, including milkweeds, as well as invasive plant species will reduce unintended damage to non-target plants.



Detailed Comments/Barriers

- Time/availability and budget. It is very difficult to train contractors and staff because time together in one place rarely occurs. Training is done through self-education and field experience.
- We generally don't damage non-target plants as part of our IVM plan, but we can't be 100% sure. We may be able to train contractors with plant identification for the various milkweed species in the future.
- There is no formal training; however, foresters are familiar with native and invasive plant species.
- We are starting to initiate staff and contractor training and awareness regarding monarchs and pollinators/habitat.
- We hire mostly contractors to conduct invasive species/plants management activities, and many of these have high turnover, making training costly and perpetual.

Train staff and contractors on updates to your IVM and land management plans and practices to reduce harm to monarchs.



Detailed Comment/Barriers

- It is very difficult to train contractors and staff because time together in one place rarely happens. IVM and land management practices pertain to tall-growing vegetation and noxious weeds. Vegetation associated with monarchs, such as nectar species and milkweed, is not target species.
- Our herbicide/IVM program is a month old. We are currently working on training staff and contractors.
- Costs, time, and lack of clear direction at this time.
- Starting to train contractors.

7
PRIORITY CONSERVATION ACTIONS FOR ELECTRIC POWER COMPANIES

With input from experts, literature, and companies, we make a first attempt to highlight overall monarch conservation opportunities for power companies. We would like to emphasize that a company can take any conservation action it deems appropriate, regardless of the results of this specific analysis. Further, although we summarize overall opportunities relative to the companies who participated in this research, a particular company may not agree with the barriers and opportunities as summarized here.

Our approach to this priority analysis was to identify the most pressing opportunities with the lowest barriers and greatest conservation potential for the monarch—the "low-hanging fruit." We therefore did not attempt to extrapolate on the more difficult conservation opportunities. We pulled from several elements for this analysis, including current scientific information on what is important for the monarch (that is, conservation actions), expert opinion, scale of implementation potential (that is, acres), and stated barriers from companies.

For **all** conservation actions, the barrier of cost, time, and resources was stated. We acknowledge this as a general barrier across all conservation actions and land asset types; however, it was not considered an insurmountable barrier. The analysis considered threats to humans and property and non-compliance with regulations (permits, local, state, federal laws/ordinances) to be issues that would be very difficult to resolve and therefore high barriers.

Expert Survey: Greatest Opportunities for Power Companies

In the Expert Survey, experts were asked, "What policies do you think power companies could enact to make the biggest difference in supporting monarchs?" Select responses are shown below.

> *1. Avoid harm. Establish long-term mowing and weed management protocols to avoid creating ecological traps for monarchs (ecological traps are areas that attract monarchs but that cannot sustain a population [Donovan and Thompson, 2001] or are then impacted to the detriment of the monarchs); 2. Focus on the sustainability of existing milkweed populations—prioritize habitat that will require minimal ongoing maintenance to persist; 3. Facilitate the expansion of existing milkweed populations along powerline corridors—focus propagation efforts in ways that mimic the natural expansion of milkweed populations along existing powerline corridors.*
>
> *Reduce mowing and herbicide application to the extent possible.*
>
> *Support Integrated Vegetation Management, including considerations for monarchs in site management plans, and mow less frequently.*

Consider type and timing of management activities, address invasive species and woody encroachment issues (critical for providing long-term habitat), consider management as a way to promote monarch habitat before planting/seeding to maximize area impacted.

1. Protect existing milkweed habitat. 2. Plant regionally appropriate milkweeds as long as property is within suitable modeled habitat for the monarch butterfly. 3. Minimize use of herbicides and insecticides.

Summary of Conservation Opportunities

First, we have attempted to summarize the conservation opportunity, based on the questions asked in the Company Survey using high, moderate, and low assignments across three factors: extent implemented, barriers, and opportunity. For "opportunity," our assessment was based on a combination of the "extent implemented" and the "barriers," with consideration of the ecological potential including input from experts. If there was "low" implementation and "low" barriers, the opportunity would be "high." On the other hand, if there was "low" implementation but "high" barriers, the opportunity would be either low or moderate, depending on a best professional judgment of the conservation value for the monarch. See Table 7-1.

Table 7-1
Opportunities for conservation actions by power companies

Conservation Action	Extent Implemented	Barriers	Opportunity
Herbicides	M	M	M
Invasive Species	L-M	M-H	M-H
Brush Management	L	M-H	L-M
Mowing	L-M	M-H	M-H
Prescribed Fire	L	H	L
Grazing	L	H	L
Restoration and Revegetation	L	M-H	M-H
Monitoring	L	H	M-H
Education, Training, and Outreach	L	L	H

L: Low M: Moderate H: High

Grazing and burning are conservation actions showing very high barriers and low implementation and applicability across all land asset types—and so are not likely the best initial opportunities for implementation. Therefore, they are not further discussed in this analysis.

Conservation Opportunities by Asset Type

> *While we aren't doing anything specific for monarch conservation, we do have a very active and growing pollinator program, which benefits monarchs. The biggest barriers for anything that we do would be budget constraints and manpower. We just don't have the field staff to help implement and monitor a lot of the recommended practices. There has also been somewhat of a hesitancy to work on easement properties, and we tend focus current efforts on company-owned properties.*
>
> Anonymous Company Survey Response

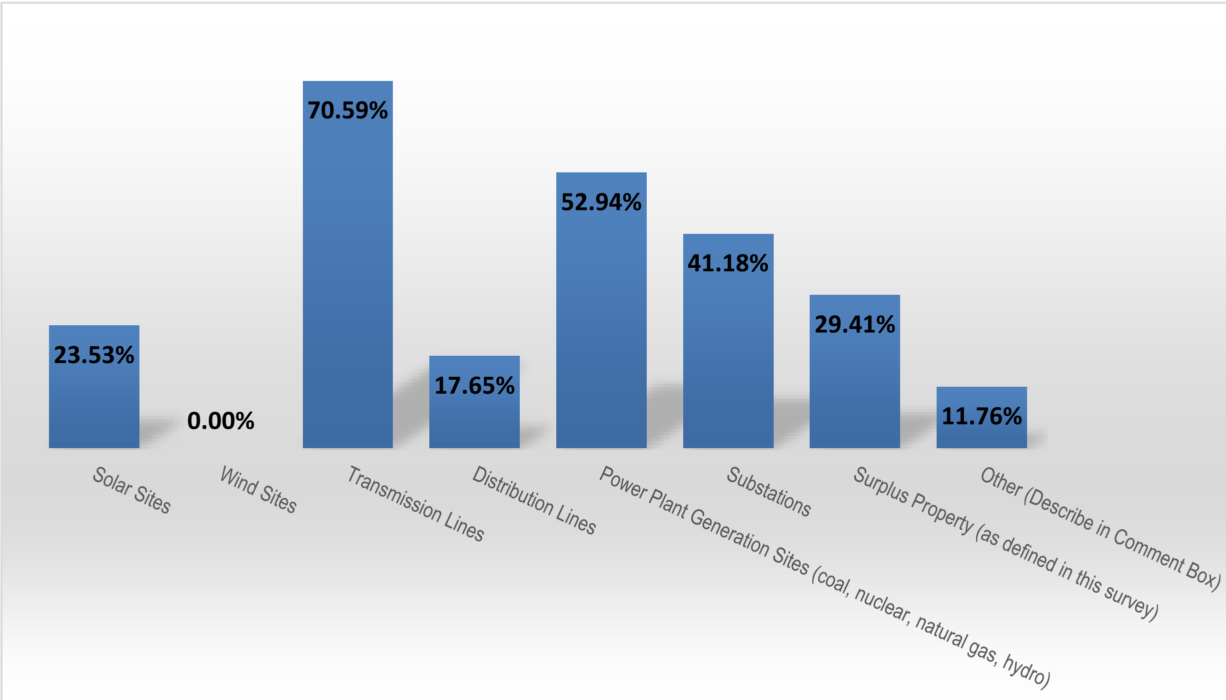
Next, we analyzed opportunities based on total acres available by land asset type. If we assume that the conservation opportunity for monarchs is correlated with the total acres available for possible conservation actions, the following prioritization would apply based on the information collected in the Company Survey:

1. Transmission Lines: 2,506,887 acres (18 companies reporting)
2. Surplus Property: 424,231 acres (7 companies reporting)
3. Power Plant Sites: 281,103 acres (15 companies reporting)
4. Wind Sites: 178,870 acres (17 companies reporting (dominated by one 103,000 acre site)
5. Substations: 42,512 acres (15 companies reporting)
6. Solar Sites: 10,800 acres (17 companies reporting)
7. Distribution Lines: 485 acres (18 companies reporting)

When we asked companies to provide an overall opinion of opportunities by land asset type, the results were as follows:

1. Transmission
2. Power Plant Sites
3. Substations
4. Surplus Property
5. Solar Sites
6. Distribution Lines
7. Other (that is, office sites, gardens)
8. Wind Sites

Considering all the barriers and opportunities, in your opinion, which of your property types has the greatest meaningful potential to support monarch habitat with the lowest barriers? (Select up to three.)



Transmission Lines

Company Survey results show extensive implementation of mowing frequency practices that are known to be complementary to monarchs. Typically, transmission lines will be managed on a multi-annual cycle, with each line being scheduled for vegetation management every 3–5 years. Therefore, it is relatively easy for most transmission lines to be mowed much less frequently than once or twice per year.

The primary opportunity for transmission lines is the use of an IVM program that considers pollinators. Such an IVM program would target the use of herbicides, use mechanical invasive weed and woody control, and avoid or eliminate aerial herbicide application. Although currently IVM programs do not prioritize a specific species (that is, monarchs) vs. a broader class of species (that is, pollinators), the practices that are implemented on transmission line ROWs to protect pollinators generally align with the conservation actions advisable to support monarchs. In addition to an IVM program to support pollinators, opportunities to integrate region-specific milkweed planting would also support monarchs and are likely feasible for many companies, with acknowledgment of concerns over local seed access and cost.

> *Transmission ROWs present the greatest opportunity for the following reasons: generally no local restrictions (see substation barriers), no concern about vegetation height or weed invasion (see solar barriers), no inspection requirements (see power plant barriers), and generally landowner cooperation. Wind sites and surplus properties may also have good potential for the same reasons, provided the vegetation does not increase the incidence of bird strikes.*

Anonymous Company Survey Response

Barriers: The vast majority of transmission lines (90%+) are managed using easements. This means that the electric power companies do not generally own these properties and will need to coordinate with the landowner to implement and/or align on their vegetation management approach (IVM plan). Where easements cut through farms, ranches, and other private property, it may not be feasible to manage the 100–200 ft transect under the transmission line for monarchs. In addition, it is difficult for companies to be dynamically responsive to the exact current conditions on sites depending on the presence/absence of monarchs or timing of blooming milkweed. With contractors pre-scheduled for their line management rotations, it may be costly and generally impractical for a business to change 3–5 year vegetation management contracts to outside the season when monarchs are breeding and migrating.

> *A barrier is for our property that is not owned by the company. We have limited control over how the sites with easements are managed, which is nearly all of our land.*
>
> Anonymous Company Survey Response

> *At the moment, there aren't any federal and state barriers that would limit us from designating conservation actions [on our transmission lines]. We generally apply very little ROW vegetation management and leave the areas mostly undisturbed while removing only targeted woody/tall-growing plant species by using selective herbicide applications. Higher level corporate management would be a major obstacle, but creating the right partnerships with stakeholders could change that.*
>
> Anonymous Company Survey Response

Surplus Property

The electric power industry owns large amounts of "surplus property" that has the potential to support monarchs. *Surplus property* was defined as total owned property that is non-operational—that is, not a power plant site, solar/wind site, ROW, part of a hydro facility, or otherwise currently managed for power generation or delivery. Although only 7 of the 18 respondents to the Company Survey were able to estimate the acres of their surplus property, EPRI is aware from experience that this property type is relevant for many electric power companies. Unlike the transecting nature of transmission lines, surplus properties tend to be contiguous parcels in both urban and rural areas, ranging from 2 to 264,000 acres in this survey alone. Further research is needed to develop a more accurate estimate of the acres encompassed by this property type at an industry level because there are no available GIS layers or maps that compile this information.

Of the conservation actions reviewed in this report, the following are most relevant to surplus property: herbicide use, revegetation/restoration, mowing, and invasive species. These sites can also be useful for education and outreach through executive field days, local school education programs, and recreation sites. With these sites not generally being associated with security restrictions, such as near a power plant, there are often solid opportunities to invite stakeholders and the public to the site. Although some of the properties will be encumbered by existing land management requirements or commitments (that is, lake or reservoir management), opportunity remains to consider these properties for pollinator and monarch support.

> *We have lands set aside for resource conservation and protection. These would be more manageable for monarch habitat and then our transmission line ROWs.*

Anonymous Company Survey Response

Barriers: Noted regulatory barriers include Resource Conservation and Recovery Act (RCRA) landfill constraints, which require mowing of vegetation over landfill sites, and the Coal Combustion Residual Rule, requiring levy and landfill slopes to be mowed frequently to facilitate inspections.

Power Plant Sites

Vegetative property surrounding power plants provides a good opportunity to be managed for pollinators and monarchs, as long as the primary safety, access, and maintenance requirements are still met for the plant. Of the conservation actions reviewed in this report, the following are most relevant to surplus property: herbicide use, revegetation/restoration, mowing, and invasive species.

Barriers: FERC hydro vegetation management requirements limit vegetation height in some cases to less than 12 inches. Similarly, NERC requirements limit vegetation options for property near nuclear power plants.

Substations

Substations are smaller sites, ranging from 1 to 15 acres (average of 3.44 acres in the Company Survey), and come with barriers related to access and maintenance requirements that limit opportunities for pollinator-friendly vegetation management. Although there are known examples of these sites being used for pollinator habitat, there are some key barriers related to site access, visibility, and equipment maintenance. Company Survey opinion showed this as the third best opportunity for monarch habitat conservation.

Barriers: Local weed ordinances were noted as barriers in the company survey responses, specifically for substations, which can be in urban areas. There are also NERC requirements as well as concerns related to interaction between equipment and vegetation.

> *Although we have approximately 300 vegetated acres associated with substations, we are required (NERC-CIP) to keep these areas clear of vegetation. We have several specific substations where we did plant pollinator mixes due to permit requirements. We do not want to attract wildlife to our substations due to significant outage risk by wildlife interactions.*
>
> Anonymous Company Survey Response

> *Safety-related visibility limitations around substations are key barriers.*
>
> Anonymous Company Survey Response

Solar/Wind Sites

Our Company Survey showed low opportunity for these property types from the company perspective. This is most likely due to the companies procuring their solar and wind power from third parties through power purchase agreements (PPAs), which means that they do not own or oversee management of the sites. However, power companies may be able to include a preference in their requests for proposals of PPAs for their solar/wind power that considers monarchs. It is generally easier to specify management practices before PPAs are in place.

Monarch habitat installation will likely have to be done during the construction period of projects, particularly for solar, to ensure that the panels are placed at an appropriate height for vegetative growth; however, other supportive actions (for example, reduced mowing) may be able to be implemented after projects are constructed. For example, at some sites it may be appropriate to use multiple seed mixes—one mix of short statured plants for under the arrays, and another mix of large statured flowering plants for around the array—as screening for the solar farm. It is also important to emphasize that solar and wind assets may become increasingly important opportunities for monarch conservation as companies transition to a portfolio with a greater contribution from renewables. See EPRI report 3002014869 (forthcoming, June 2019) for more discussion of emerging “pollinator-friendly solar” standards and scorecards.

Barriers: The height of the panels is an important consideration for solar-pollinator projects to materialize. Raising the panels to support plant height may be costly for new construction and retrofitting existing construction. With a large portion of solar power being acquired through power purchase agreements, arrangements will be needed between the power company and the solar developer to support pollinators. When the solar panels are owned by the power company (rather than the solar developer), there may be encumbrances related to using the land, as articulated in this statement:

> *All of our wind energy facilities are associated with lands leased from private landowners such as farmers and ranchers. Little potential exists, at these sites, for the installation of pollinator habitat.*
>
> Anonymous Company Survey Response

Distribution Lines

Use of distribution lines is showing low potential as a top monarch conservation opportunity for power companies. Distribution lines are much smaller in width and overall acres compared to the other asset types. They tend to run along roadways, which helps with site access for vegetation management, but are not generally owned and managed (<10% on average) by power companies. Management of these areas typically falls to a diverse group of land managers such as local or state departments of transportation, neighbors, or other parties—making coordinated implementation of monarch conservation actions an extensive education and outreach undertaking. Compared to the other opportunities, these sites are not likely to be the best initial place for electric power companies to support monarchs.

All Asset Types

Two conservation actions are appropriate to consider independent of asset type: habitat monitoring and education/training/communication. Habitat monitoring carries barriers, as discussed above, but is vital to better understanding where existing habitat is located so that it can be protected and managed appropriately. Education, training, and communication are presented in this research as an overall set of activities; however, they are quite different depending on the goal. Training of field staff for the purpose of changing vegetation management practices has higher barriers (discussed above) compared to corporate-level communications (blog posts, Twitter announcements, employee newsletters). See “Case Study: EPRI Power-in-Pollinators National Pollinator Week” in Section 6.

Case Study: Dairyland Power Cooperative Adding Solar and Pollinators

In 2016, Dairyland Power Cooperative (Dairyland) entered into an agreement with ENGIE (then SoCore Energy) and CMS Energy to purchase 25 megawatts of energy from 18 solar projects located throughout Dairyland's service territory of Wisconsin, Minnesota, Iowa, and Illinois. Each of the solar generation sites provides beneficial pollinator habitat, with the 18 sites equating to approximately 250 acres of newly created pollinator habitat.

Prairie Restorations, Inc. (PRI) designed and installed the sites, which were seeded with native prairie seed mixes especially suited to the specific geographic location and conditions at each site (see Figure 7-1). The seed mixes included both common and whorled milkweed to aid in monarch butterfly conservation. PRI continues to maintain the sites by conducting two to three site visits a year to mow, spray, re-seed, and remove weeds as necessary.

Figure 7-1
A solar project showing the establishment of the seeded prairie mix

8
SUMMARY

> *There is a great opportunity to prevent the listing of the Monarch butterfly through the implementation of certain vegetation management practices. These need to be balanced against the need to provide affordable electricity to our customers. There are many other concurrent benefits with the management of vegetation for the butterfly (erosion control, drought tolerance, fire management, tree inhibition) that can also help justify these practices. More information to reinforce these programs and their benefits will help secure their future implementation.*
>
> Anonymous Company Survey Response

Please refer to the full list of limitations related to this research in the Limitations section.

The primary threats to monarchs include habitat loss, pesticides, and climate change. Monarch breeding and migratory habitat is found broadly over the vast majority of the lower 48 states and into southern Canada; monarch overwintering habitat in the United States is found primarily along the coast of California. Because it is important to conserve monarch habitat in all of the regions in which it occurs, nearly every electric power company in the United States has an opportunity to support monarch conservation. The conservation actions included in this report can play a role in the recovery of monarchs and were identified by experts as having opportunity for power companies to contribute to monarch conservation.

Through this project, it became clear that electric power companies value the monarch butterfly and are interested in helping the monarch recover. Motivations include good public relations, inherent concern for impacting a culturally iconic species, responding to employee requests to support pollinators, and avoiding operational risk and cost if the monarch receives state or federal legal protection. With these broader interests and motivations, this report will be a long-standing resource for companies wanting a comprehensive list of possible conservation options to consider, regardless of whether the monarch receives federal protection under the U.S. Endangered Species Act.

This research reveals that considering conservation actions independent of the property type or on-field site conditions is unlikely to highlight legitimate and specific conservation opportunities. Rather, we found it necessary to look at each property asset type to understand the applicable conservation actions and barriers. Generalized statements about “power companies” and “conservation actions” likely need to be unraveled, given the diversity of the electric power industry and the broad suite of land types they manage through ownership, easements, and lease agreements.

Challenges for Monarch Conservation

The challenge for power companies is to find ways to meet their obligation to protect human safety, provide electricity at reasonable and predictable prices, and deliver their product consistently with minimal interruptions—while also supporting monarchs.

A key finding in this research was that most electric power companies embed monarchs within their larger pollinator conservation efforts—if they even have those efforts in place. It may be much harder for companies to call out a specific species in their land management programs rather than manage the site to support a suite of pollinator species that includes monarchs. Rather, it may make more sense to add language to consider vegetation management efforts "with a particular effort to support declining pollinator species."

If the monarch is listed under the United States Endangered Species Act (or through state listings), regulatory implications may change what power companies can do in monarch habitat. Because no listing decision has been made at the time of publication, speculating on regulations the U.S. Fish and Wildlife Service may establish is outside the scope of this report. However, it is notable that even if the monarch is listed, critical habitat designations can take years to be established and take effect (for example, rusty patched bumble bee was listed in 2017, and no critical habitat has been designated to date).

Other key monarch conservation challenges are as follows:

- Not all power companies have a clear idea about where monarch habitat is located on their properties. This makes protection and monarch-friendly management difficult to implement in many areas.
- Cost and time were listed as barriers across all asset types and for the majority of conservation actions included in the Company Survey.
- Transmission lines versus distribution lines need to be considered separately in the context of monarchs, pollinators, and biodiversity support in general. The blanket consideration of ROWs will not reveal the best ecological opportunities with the lowest implementation barriers.
- The vast majority of transmission lines—a key opportunity for monarch conservation efforts—is managed through easements that will influence power company land management options.
- Conservation actions that call for land management or IVM implementation that relies on milkweed identification and (to a lesser degree) outside the monarch breeding window are difficult. Contractors are on a schedule and may not be able to work around the monarch breeding window or milkweed blooming.
- Training contractors who have a high risk of reassignment creates a continuous annual burden that can be very costly and time consuming.
- A few specific regulations are barriers for monarch and pollinator habitat support, particularly at substations and hydro sites.

Opportunities for Monarch Conservation

This research attempts to highlight the best conservation opportunities for the monarch that electric power companies can implement. The effort is significant because it is difficult to rank the value of the various conservation actions themselves for the monarch, let alone map the conservation actions to specific property types based on current management practices and future conservation opportunities. With our best attempt at this effort, we identified the following top opportunities, although these will certainly vary for individual companies:

- Experts agree that identifying, protecting, and managing **existing** monarch habitat is very beneficial and should be the first focus of power companies. This may involve monitoring in order to understand the location of existing habitat.
- Altering management practices to be more monarch-friendly is the second biggest opportunity for power companies to contribute to the species' conservation. Habitat maintenance, restoration, and creation are important actions power companies can take.
- Habitat monitoring, including identifying areas in which monarch habitat occurs on land managed by power companies, and general education and communication opportunities can be considered across all land asset types and have high conservation value for monarchs.
- Transmission lines: Consider an IVM plan to specifically protect pollinators with particular consideration to monarchs. Promote the native low-growing plant community; apply herbicides judiciously; revegetate with a pollinator-friendly seed mix, including locally native milkweed; manage invasive vegetation with targeted and/or mechanical means; when possible, mow/control brush in areas with monarch habitat outside the monarch breeding window for your region.
- Power plant properties: To the extent possible while still allowing for site access and clearance requirements, plant pollinator-friendly seed mixes, including locally native milkweed. Adopt a site management plan that incorporates relevant conservation actions noted in this report—including sensible herbicide use and shifting of mowing frequency and/or timing.
- Substations: To the extent possible while allowing for site access and equipment clearance requirements, plant pollinator-friendly seed mixes including locally native milkweed. Practice judicious herbicide use and reduce mowing frequency and/or timing. Given the smaller footprint of substations as individual properties, consider prioritizing your substations for planting based on adjacency to other protected areas that may provide pollinator habitat, if possible.
- Surplus property: Surplus properties have a large range of possible sizes. Ideally, start with the properties that are larger in size to allow for expansion of pollinator revegetation/restoration projects going forward. Adopt a site management plan that incorporates the conservation actions noted in this report. Plant pollinator-friendly seed mixes including locally native milkweed. Practice sensible herbicide use and reduce mowing frequency and/or timing.

With the increasing amounts of wind and solar power in North America, it is likely that consideration of these property types will become more relevant for monarchs and other pollinators going forward. However, it is likely that an increasing portion of those sites will be owned by emerging power providers and not the traditional electric power companies. For renewable power, power companies can consider adding preferences for pollinator-friendly solar and wind into power purchase agreements (EPRI report 3002014869, forthcoming June 2019, will contain more discussion).

Future Research Opportunities

During this effort, the following key future research opportunities were identified:

- Monitoring of **existing** monarch habitat on power company properties is a crucial gap for both the species and power companies' ability to identify, protect, and manage the butterfly's habitat. Follow-up projects to identify the location of existing habitat could include developing a monitoring and inventory scheme; applying research techniques such as remote-sensing and habitat suitability to map and model milkweed; and/or collating existing monarch, milkweed, and habitat suitability models and data sets for use by electric power companies.
- Collaboration to develop and distribute communication tools such as educational materials and social media posts to raise awareness about monarch biology, the plight of the species, and how power companies are contributing to monarch conservation.
- Develop site- or company-specific management plans for monarch conservation action implementation and IVM programs.
- Develop more specific guidance regarding the implementation of the conservation actions described in this report.

9
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A
EXPERT SURVEY

1. What do you think would be the impact of the following management actions in areas (habitats & geographic regions) which support monarchs? Please rank each of the following actions from “harmful” to “very beneficial” (options include “harmful”, “neutral/no effect”, “somewhat beneficial”, “very beneficial”, “it’s complicated (beneficial/harmful in different contexts)”, and “I’m not sure”) from the perspective of the action’s overall impact on monarch populations. Use the notes section below to add any caveats or additional details about your rankings. Do not consider feasibility of implementation in answering this question; only consider the potential effect on monarchs & their habitat.
    - Control woody plant encroachment
    - Control invasive herbaceous plants which are not known to be nectar sources for monarchs
    - Control invasive herbaceous plants which are known to be nectar sources for monarchs
    - Limit broadcast herbicide use; using spot spraying for vegetation management
    - Limit mowing to one cut per growing season
    - Limit mowing to two cuts per growing season
    - Mow during the season(s) when monarchs are not present
    - Mow during the season(s) when monarchs are present
    - Spot mow to avoid milkweed and/or nectar plants
    - Install new monarch habitat at a restoration-scale (> ¼ acre)
    - Install new monarch habitat at the garden-scale (< ¼ acre)
    - Protect existing monarch habitat (for example, from pesticides, removal, etc.)
    - Increase use of native milkweed species in seed mixes used in reseeding/restoration efforts
    - Increase use of native nectar species in seed mixes used in reseeding/restoration efforts
    - Train managers, staff, and/or contractors to identify and protect milkweed & important nectar plants
    - Increase communication & coordination with private land owners within ROW about protecting monarch habitat
    - Outreach to the public, shareholders, and/or customers about importance of monarch conservation
    - Provide any notes or perspectives about the management action rankings you selected (Optional)

2. What are the top three most important management actions (from the list above or others) that power companies can take to help monarchs?
3. Please rank the feasibility (in your opinion) of implementation the same management actions by power companies (on at least some portion of the land they manage) from “not feasible” to “highly feasible”. Options include “not feasible”, “somewhat feasible”, “very feasible”, and “I’m not sure”
    - Control woody plant encroachment
    - Control invasive herbaceous plants which are not known to be nectar sources for monarchs
    - Control invasive herbaceous plants which are known to be nectar sources for monarchs
    - Limit broadcast herbicide use; using spot spraying for vegetation management
    - Limit mowing to one cut per growing season
    - Limit mowing to two cuts per growing season
    - Mow during the season(s) when monarchs are not present
    - Mow during the season(s) when monarchs are present
    - Spot mow to avoid milkweed and/or nectar plants
    - Install new monarch habitat at a restoration-scale (> ¼ acre)
    - Install new monarch habitat at the garden-scale (< ¼ acre)
    - Protect existing monarch habitat (for example, from pesticides, removal, etc.)
    - Increase use of native milkweed species in seed mixes used in reseeding/restoration efforts
    - Increase use of native nectar species in seed mixes used in reseeding/restoration efforts
    - Train managers, staff, and/or contractors to identify and protect milkweed & important nectar plants
    - Increase communication & coordination with private land owners within ROW about protecting monarch habitat
    - Outreach to the public, shareholders, and/or customers about importance of monarch conservation
4. Do you think that a resurgence in milkweed following a single mowing event in the spring or mid-summer is beneficial to monarchs by extending the availability of new milkweed stems for egg-laying/caterpillar development in the late summer or early fall? Or is it detrimental by possibly causing mortality of monarch immatures and/or reducing nectar availability? Please explain any differences between geographic regions or milkweed species.
5. In what geographic regions and during what seasons do you think monarchs are limited by milkweed availability in their breeding & migratory range?

6. In what geographic regions and during what seasons do you think monarchs are limited by nectar availability in their breeding & migratory range?
7. What milkweed species (1 or more) do you think are the most important for monarchs in your geographic region? Other regions? List geographic regions next to answers.
8. What plants (family, genus, species, and/or common name) do you think are the most important nectar sources for monarchs during the SPRING in your geographic region? In other geographic regions? List geographic regions next to answers.
9. What plants (family, genus, species, and/or common name) do you think are the most important nectar sources for monarchs during the SUMMER in your geographic region? In other geographic regions? List geographic regions next to answers.
10. What plants (family, genus, species, and/or common name) do you think are the most important nectar sources for monarchs during the FALL in your geographic region? In other geographic regions? List geographic regions next to answers.
11. How would you describe high-quality habitat for monarchs?
12. What is the minimum evidence or information you would need to determine if a power companies' property is supporting monarch habitat? (Select all that apply)
    - Land cover type (for example, grassland, roadside, urban/developed, row crop agriculture, shrub-steppe)
    - Field monitoring on that specific property
    - Field monitoring on a representative sample of similar land cover types in a broad geographic region (for example, forest edges in Idaho)
    - Geographic location
    - Other information
    - None of the above
    - Provide any notes or perspectives about the minimum information needed to determine if a property supports monarch habitat (Optional)
13. If field monitoring is conducted, what data is the highest priority to collect? Options include "not a priority", "low priority", "moderate priority", "high priority", and "I'm not sure"
    - Milkweed presence/absence
    - Milkweed stem or plant density
    - Monarch adult presence
    - Monarch adult abundance
    - Monarch immature presence
    - Monarch immature abundance
    - Nectar plant abundance and/or diversity
    - Provide any notes or perspectives about field monitoring (Optional)

14. What policies do you think power companies could enact to make the biggest difference in supporting monarchs?
15. What efforts taken by power companies to support monarchs would be most beneficial to support other pollinator species as well?
16. Have you been involved with, or are aware of case studies or examples of successful vegetation management approaches that protect monarchs or other butterflies on land managed by power companies? If so, please describe.
17. Is there any additional information or thoughts that relates to power companies' management of monarch habitat that you would like to share with us?

B
COMPANY SURVEY

EPRI-Member Survey Data Collection Worksheet: Monarch Conservation Actions

Instructions

This data collection worksheet is provided as a convenience to capture information that will ultimately be entered into the online survey. EPRI will provide a link to the online survey separately.

ONE RESPONSE PER COMPANY.

DEADLINE FOR ENTRY TO ONLINE SURVEY: TUESDAY OCTOBER 2, 2018.

Boundary of Responses:

Responses entered should be associated with the company name entered. For example, if you enter your parent company name, then all response should be representative of the larger parent company. If you are entering data only for a subsidiary, enter the subsidiary name as the "Name of Company."

Clarifying Q&A:

Full data accuracy would likely require detailed GIS analysis to separate out vegetative vs non-vegetative areas. We are NOT asking you to do this. When data are limited, we would like you to use best professional judgment in answering the questions with your best attempt to estimate vegetative areas.

We previously provided the following boundary on the metrics reporting: "*Under the "Overall Corporate Metrics," include land that you own AND/OR have vegetation management responsibilities. You would exclude land that you do not own AND do not manage—that is, a line easement over a farm field*." However, subtracting land that you do not own AND do not manage from the Transmission Easement and Distribution Easement metrics will likely be exceedingly difficult. Therefore, it is acceptable to report your full easement miles information.

We are adding a comment field to the online survey to capture "Caveats/Assumptions" related to the Overall Corporate Metrics. This will provide an opportunity to tell us more details on the data you are reporting.

T&D Classification: Lines 69kV should put under "Transmission" in the survey. Lines 34.5kV should be put under "Distribution" in the survey.

Under the Overall Corporate Metrics, "Managed Lands" refers to land that you have some level of responsibility to manage via ownership, lease, or easement. It does not necessarily imply that the property is being actively managed for a particular goal already, although that could be the case.

Purpose and Value

The Electric Power Research Institute (EPRI) is working to evaluate the opportunities for power companies to contribute to monarch butterfly conservation. This research is important for understanding both the theoretical conservation opportunities (driven by science) and the realities of action (driven by policies, permits, costs, business commitments, etc.). This EPRI-member survey will collect important information to inform the broader national discussion about how to protect monarchs.

In taking this survey, please consider ALL your managed lands: Rights-of-Ways (ROWs), solar and wind fields, surrounding power plants, upland of hydro dams, and other corporate real estate assets.

Note that *monarch habitat* in this survey is defined as breeding and migratory habitat. Overwintering habitat is not included in the scope of this survey. The main tenets of monarch breeding and migratory habitat are:

1. Native milkweeds that provide food for monarch caterpillars and nectar for adults.
2. Flowers that provide nectar for adults—ideally a diversity of native species with overlapping flowering phenologies throughout the growing season.

COMPANY-SPECIFIC RESPONSES WILL BE KEPT CONFIDENTIAL.
ALL INPUT WILL BE COMBINED TO PROVIDE OVERALL RESULTS.
ONE RESPONSE PER COMPANY.

CONTACT INFORMATION

Reminder: Responses entered should be associated with the company name entered. For example, if you enter your parent company name, then all response should be representative of the larger parent company. If you are entering data only for a subsidiary, enter the subsidiary name as the "Name of Company."

Name of Company Represented in Answers:

____

Name of Survey Taker:

____

OVERALL CORPORATE METRICS

Total Electricity Generation in MW: ______________________________

Total Purchased Electric Power in MW: ______________________________

Total Electricity Delivered in MW: ______________________________

The following questions request input regarding the land that COULD be planted with a vegetative community to support monarchs. Areas that COULD theoretically be planted include non-concrete areas, open soil, and currently vegetative sites. In responding to these questions, DO NOT consider restrictions such as vegetation maintenance requirements, permit restrictions, or licensing requirements; such barriers will be captured later in the survey.

Total vegetative land managed around Power Plants:

- Number of Power Plants: ______________________________
- Total vegetative acres of ALL power plant sites: ______________________________

Total vegetative land managed under TRANSMISSION lines:

- Total Miles: ______________________________
- Average Width (feet): ______________________________
- % Transmission Lines OWNED: ______________________________
- % Transmission Lines LEASED: ______________________________
- % Transmission Lines managed via EASEMENTS: ______________________________

Total vegetative land managed under DISTRIBUTION lines:

- Total Miles:____
- Average Width (feet): ____________________________________
- % Distribution Lines OWNED: ______________________________
- % Distribution Lines LEASED: ______________________________
- % Distribution Lines managed via EASEMENTS: ____________________

Total vegetative land at Substations:

- Total Number of substations: ______________________________
- Total vegetative acres of ALL substations: ______________________

Owned Solar sites:

- Total Number of solar sites: _______________________________
- Total size of ALL solar sites in acres: _________________________

Owned Wind farms:

- Total Number of wind farms: ______________________________
- Total size of ALL wind farms in acres: _________________________

"Surplus" Property: Estimate total OWNED property that is non-operational, meaning NOT a power plant site, solar/wind site, ROW, part of a hydro facility, or otherwise currently managed for power generation or delivery.

- Number of sites/parcels: __________________________________
- Total Acres of ALL surplus sites/parcels: _______________________

Estimate what percent of your total owned property is leased to farmers?

☐ 0–10% ☐ 11–25% ☐ 26–50% ☐ more than 50% ☐ Don't Know

GENERAL MONARCH QUESTIONS

Does the possibility of the monarch becoming legally protected by the Endangered Species Act create incentives to proactively implementing, reporting, and/or evaluating monarch habitat in your managed areas?

☐ Yes ☐ No ☐ Somewhat ☐ No Opinion/Don't Know

Does the possibility of the monarch becoming legally protected by the Endangered Species Act cause barriers to proactively implementing, reporting, and/or evaluating monarch habitat in your managed areas?

☐ Yes ☐ No ☐ Somewhat ☐ No Opinion/Don't Know

Do you understand the steps that the U.S. Fish and Wildlife Service is using to determine if the monarch is listed?

☐ Yes ☐ No ☐ Somewhat ☐ No Opinion/Don't Know

Do you anticipate submitting monarch habitat data to the U.S. Fish and Wildlife Service Monarch Conservation Database, which is one data source being referenced to determine the extent to which monarchs need further protection as part of the listing decision?

☐ Yes ☐ No ☐ Maybe ☐ Don't Know

Are the executives in your company concerned about the possibility of the monarch being federally listed?

☐ Yes ☐ No ☐ Somewhat ☐ No Opinion/Don't Know

MONARCH PROJECTS AND DATA

Have you proactively undertaken measures to conserve monarch butterflies or provide monarch-friendly pollinator habitat (for example, altered management practices to enhance habitat or installed new monarch habitat)?

☐ Yes ☐ No ☐ Don't Know

If yes, please describe (type of project, landholding type involved [solar, surplus, substation, etc.], estimated size of habitat, etc.).

If yes, was the project done in collaboration with a nonprofit, federal/state, or stakeholder group?

Have you estimated the extent of current monarch-friendly habitat within your managed property, whether proactively installed, existing, or otherwise? ("Monarch-friendly" means native milkweeds, which provide food for monarch caterpillars and nectar for adults and/or flowers that provide nectar for adults—ideally a diversity of native species with overlapping flowering phenologies throughout the growing season.)

☐ Yes ☐ Partially ☐ No ☐ Don't Know

If yes or partially, please describe your approach/methods for this estimate.

If yes or partially, please enter the quantitative estimate of monarch habitat in acres/hectares.

Do you have an Integrated Vegetation Management (IVM) objective specifically to support monarchs?

☐ Yes ☐ No ☐ Don't Know ☐ N/A

If yes, describe the management activities defined to support monarchs.

Examples of power companies supporting monarchs <u>and other pollinators</u>, even without detailed field study information, may be useful for highlighting to stakeholders and agencies conservation examples. Do you have monarch conservation stories or case studies that you would like to highlight in an EPRI report?

☐ Yes ☐ Maybe ☐ No

Please include a short description. We will follow up to collect more details and photos.

What were the primary motivations for your current or past monarch conservation projects?

☐ Part of a corporate sustainability goal

☐ Stakeholder goodwill/public visibility

☐ Investor request, demand, relations

☐ Responding to collaboration/community request or opportunity

☐ Part of an agency permit, agreement, mitigation (HCP, CCAA, plant permit, etc.)

☐ Other: ____

CONSERVATION ACTION FEASABILITY

The following section requests information associated with various land management practices that may be associated with monarch conservation/impacts. For EACH PROPERTY TYPE, please:

1. Rate actions for **Extent Implemented**, meaning extent ALREADY implemented in the relevant property type.
2. Provide a brief explanation of the **Barriers** for implementation (for example, staff training, financial constraints, equipment limitations, incompatibility with other goals, staff resources, permit or legal limitations, etc.).

Term Definitions:

- Extent Implemented: High = 70–100%, Moderate 40–69%, Low 5–39%, None <5%.
- Power Plants = Hydro, coal, nuclear, natural gas (every generation type except solar/wind).
- Surplus Property = OWNED property that is non-operational, meaning NOT a power plant site, solar/wind site, ROW, part of a hydro facility, or otherwise currently managed for power generation or delivery.

Mowing

- Limit mowing to no more than twice per year.
  - Transmission Line ROW
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ____________________
  - Distribution Line ROW
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ____________________
  - Solar/Wind
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ____________________
  - Substations
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ____________________
  - Around Power Plants
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ____________________

- Surplus Property
  - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
  - Barriers ______________________________
- Other Property Class/Type: [List]
  - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
  - Barriers ______________________________
  - Describe property class/type ______________________________

- Avoid mowing vegetation when it includes milkweed during the monarch breeding season in your area (generally between spring and first frost).
  - Transmission Line ROW
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ______________________________
  - Distribution Line ROW
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ______________________________
  - Solar/Wind
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ______________________________
  - Substations
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ______________________________
  - Around Power Plants
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ______________________________
  - Surplus Property
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ______________________________

– Other Property Class/Type: [List]

  - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
  - Barriers ______________________________
  - Describe property class/type ______________________________

- Delay mowing until after the monarch breeding and migration season (after late summer or fall, depending on your region).

– Transmission Line ROW

  - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
  - Barriers ______________________________

– Distribution Line ROW

  - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
  - Barriers ______________________________

– Solar/Wind

  - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
  - Barriers ______________________________

– Substations

  - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
  - Barriers ______________________________

– Around Power Plants

  - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
  - Barriers ______________________________

– Surplus Property

  - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
  - Barriers ______________________________

– Other Property Class/Type: [List]

  - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
  - Barriers ______________________________
  - Describe property class/type ______________________________

- Spot mow to avoid milkweed and/or nectar plants; focus on mowing target plants.
  - Transmission Line ROW
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ____________________
  - Distribution Line ROW
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ____________________
  - Solar/Wind
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ____________________
  - Substations
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ____________________
  - Around Power Plants
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ____________________
  - Surplus Property
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ____________________
  - Other Property Class/Type: [List]
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ____________________
    - Describe property class/type ____________________
- Adjust mowing height to a minimum height of 10–12 inches in areas with milkweed in the spring.
  - Transmission Line ROW
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ____________________

- Distribution Line ROW
  - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
  - Barriers ____
- Solar/Wind
  - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
  - Barriers ____
- Substations
  - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
  - Barriers ____
- Around Power Plants
  - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
  - Barriers ____
- Surplus Property
  - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
  - Barriers ____
- Other Property Class/Type: [List]
  - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
  - Barriers ____
  - Describe property class/type ________________________________

- Mow no more than one-third of a management area per year.
  - Transmission Line ROW
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ____
  - Distribution Line ROW
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ____
  - Solar/Wind
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ____

- Substations
  - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
  - Barriers ____________________
- Around Power Plants
  - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
  - Barriers ____________________
- Surplus Property
  - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
  - Barriers ____________________
- Other Property Class/Type: [List]
  - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
  - Barriers ____________________
  - Describe property class/type ____________________

Prescribed fire

- Burn areas with milkweed outside the monarch breeding season in your area (burn windows generally include fall and winter for all regions as well as spring for the Upper Midwest and Northeast [no later than April] and for the Pacific Northwest and northern parts of the Interior West [no later than May]).
  - Transmission Line ROW
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ____________________
  - Distribution Line ROW
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ____________________
  - Solar/Wind
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ____________________
  - Substations
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ____________________

- Around Power Plants
  - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don’t Know
  - Barriers ____
- Surplus Property
  - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don’t Know
  - Barriers ____
- Other Property Class/Type: [List]
  - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don’t Know
  - Barriers ____
  - Describe property class/type ______________________________

* Avoid burning right before or during spring or fall migration in your area.
  - Transmission Line ROW
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don’t Know
    - Barriers ____
  - Distribution Line ROW
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don’t Know
    - Barriers ____
  - Solar/Wind
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don’t Know
    - Barriers ____
  - Substations
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don’t Know
    - Barriers ____
  - Around Power Plants
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don’t Know
    - Barriers ____
  - Surplus Property
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don’t Know
    - Barriers ____

- Other Property Class/Type: [List]
  - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
  - Barriers ____
  - Describe property class/type ______________________________

- Burn a site once every 3–10 years, or longer depending on the natural fire interval of the site.
  - Transmission Line ROW
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ____
  - Distribution Line ROW
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ____
  - Solar/Wind
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ____
  - Substations
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ____
  - Around Power Plants
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ____
  - Surplus Property
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ____
  - Other Property Class/Type: [List]
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ____
    - Describe property class/type ______________________________

- Burn only one-third of a management area per year.
  - Transmission Line ROW
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ____
  - Distribution Line ROW
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ____
  - Solar/Wind
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ____
  - Substations
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ____
  - Around Power Plants
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ____
  - Surplus Property
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ____
  - Other Property Class/Type: [List]
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ____
    - Describe property class/type ________________________________
- If you have skips (unburned areas) within your burn units, leave them unburned.
  - Transmission Line ROW
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ____

- Distribution Line ROW
  - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
  - Barriers ______________________________
- Solar/Wind
  - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
  - Barriers ______________________________
- Substations
  - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
  - Barriers ______________________________
- Around Power Plants
  - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
  - Barriers ______________________________
- Surplus Property
  - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
  - Barriers ______________________________
- Other Property Class/Type: [List]
  - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
  - Barriers ______________________________
  - Describe property class/type ______________________________

- Include native monarch nectar plants and milkweed species in post-fire restoration, if needed.
  - Transmission Line ROW
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ______________________________
  - Distribution Line ROW
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ______________________________
  - Solar/Wind
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ______________________________

- Substations
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ____
- Around Power Plants
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ____
- Surplus Property
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ____
- Other Property Class/Type: [List]
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ____
    - Describe property class/type ______________________________

Grazing

- Keep grazing intensity low (low Animal Unit Months [AUM] for site or allotment) for season-long grazing or use High-Density Short Duration (HDSD) and/or rest-rotation grazing schemes.
    - Transmission Line ROW
        - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
        - Barriers ____
    - Distribution Line ROW
        - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
        - Barriers ____
    - Solar/Wind
        - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
        - Barriers ____
    - Substations
        - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
        - Barriers ____

- Around Power Plants
  - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
  - Barriers ______________________________
- Surplus Property
  - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
  - Barriers ______________________________
- Other Property Class/Type: [List]
  - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
  - Barriers ______________________________
  - Describe property class/type ______________________________

- Graze only one-third of a management area per year.
  - Transmission Line ROW
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ______________________________
  - Distribution Line ROW
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ______________________________
  - Solar/Wind
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ______________________________
  - Substations
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ______________________________
  - Around Power Plants
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ______________________________
  - Surplus Property
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ______________________________

- Other Property Class/Type: [List]
  - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
  - Barriers ____________________
  - Describe property class/type ____________________
- Utilization rates up to but not exceeding 40% of the current season's growth.
  - Transmission Line ROW
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ____________________
  - Distribution Line ROW
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ____________________
  - Solar/Wind
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ____________________
  - Substations
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ____________________
  - Around Power Plants
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ____________________
  - Surplus Property
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ____________________
  - Other Property Class/Type: [List]
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ____________________
    - Describe property class/type ____________________

- Adjust grazing time to fall or winter grazing when milkweed is dormant and monarchs are not breeding, which is generally between first frost and spring.
  - Transmission Line ROW
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ____________________
  - Distribution Line ROW
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ____________________
  - Solar/Wind
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ____________________
  - Substations
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ____________________
  - Around Power Plants
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ____________________
  - Surplus Property
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ____________________
  - Other Property Class/Type: [List]
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ____________________
    - Describe property class/type ____________________
- Avoid grazing the same location at the same time every year.
  - Transmission Line ROW
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ____________________

- Distribution Line ROW
  - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
  - Barriers ____
- Solar/Wind
  - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
  - Barriers ____
- Substations
  - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
  - Barriers ____
- Around Power Plants
  - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
  - Barriers ____
- Surplus Property
  - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
  - Barriers ____
- Other Property Class/Type: [List]
  - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
  - Barriers ____
  - Describe property class/type ______________________________

Managing invasive plant species

- Control herbaceous invasive plants in addition to woody invasive species.
  - Transmission Line ROW
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ____
  - Distribution Line ROW
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ____

- Solar/Wind
  - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
  - Barriers ____________________
- Substations
  - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
  - Barriers ____________________
- Around Power Plants
  - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
  - Barriers ____________________
- Surplus Property
  - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
  - Barriers ____________________
- Other Property Class/Type: [List]
  - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
  - Barriers ____________________
  - Describe property class/type ____________________

- Clean mowing equipment after use and between sites to limit the spread of invasive plant species.
  - Transmission Line ROW
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ____________________
  - Distribution Line ROW
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ____________________
  - Solar/Wind
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ____________________
  - Substations
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ____________________

– Around Power Plants

  - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
  - Barriers ____________________

– Surplus Property

  - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
  - Barriers ____________________

– Other Property Class/Type: [List]

  - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
  - Barriers ____________________
  - Describe property class/type ____________________

- Time management of invasive plants for periods when they are most vulnerable (for example, before bloom).

– Transmission Line ROW

  - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
  - Barriers ____________________

– Distribution Line ROW

  - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
  - Barriers ____________________

– Solar/Wind

  - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
  - Barriers ____________________

– Substations

  - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
  - Barriers ____________________

– Around Power Plants

  - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
  - Barriers ____________________

– Surplus Property

  - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
  - Barriers ____________________

- Other Property Class/Type: [List]
  - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
  - Barriers ____
  - Describe property class/type ______________________________

- Before or directly following invasive plant removal on a large scale, ensure that there will be similar or enhanced native floral resources available by implementing a revegetation plan.
  - Transmission Line ROW
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ____
  - Distribution Line ROW
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ____
  - Solar/Wind
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ____
  - Substations
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ____
  - Around Power Plants
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ____
  - Surplus Property
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ____
  - Other Property Class/Type: [List]
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ____
    - Describe property class/type ______________________________

Brush control

- Where appropriate, maintain open canopy forests with low shrub cover and high diversity of flowering forbs and shrubs through thinning, brush hogs, mowing, grazing, etc.
  - Transmission Line ROW
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ______________________________
  - Distribution Line ROW
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ______________________________
  - Solar/Wind
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ______________________________
  - Substations
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ______________________________
  - Around Power Plants
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ______________________________
  - Surplus Property
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ______________________________
  - Other Property Class/Type: [List]
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ______________________________
    - Describe property class/type ______________________________
- If fuels reduction or thinning will involve fuel understory burns, implement outside the active season of monarchs.
  - Transmission Line ROW
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ______________________________

- Distribution Line ROW
  - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
  - Barriers ______________________________
- Solar/Wind
  - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
  - Barriers ______________________________
- Substations
  - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
  - Barriers ______________________________
- Around Power Plants
  - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
  - Barriers ______________________________
- Surplus Property
  - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
  - Barriers ______________________________
- Other Property Class/Type: [List]
  - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
  - Barriers ______________________________
  - Describe property class/type ______________________________

- Minimize soil disturbance (disking, tilling) during restoration activities to avoid spreading invasive plants.
  - Transmission Line ROW
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ______________________________
  - Distribution Line ROW
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ______________________________
  - Solar/Wind
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ______________________________

- Substations
  - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
  - Barriers ____________________
- Around Power Plants
  - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
  - Barriers ____________________
- Surplus Property
  - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
  - Barriers ____________________
- Other Property Class/Type: [List]
  - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
  - Barriers ____________________
  - Describe property class/type ____________________

Revegetation

- Include at a minimum one native milkweed species (if habitat is appropriate) in revegetation projects.
  - Transmission Line ROW
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ____________________
  - Distribution Line ROW
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ____________________
  - Solar/Wind
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ____________________
  - Substations
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ____________________

- Around Power Plants
  - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
  - Barriers ______________________________
- Surplus Property
  - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
  - Barriers ______________________________
- Other Property Class/Type: [List]
  - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
  - Barriers ______________________________
  - Describe property class/type ______________________________

- Plant native, monarch-attractive nectar species that will provide floral resources throughout the breeding season, with a minimum of three species in bloom at any time between spring and fall.
  - Transmission Line ROW
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ______________________________
  - Distribution Line ROW
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ______________________________
  - Solar/Wind
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ______________________________
  - Substations
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ______________________________
  - Around Power Plants
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ______________________________

- Surplus Property
  - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don’t Know
  - Barriers ____
- Other Property Class/Type: [List]
  - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don’t Know
  - Barriers ____
  - Describe property class/type ______________________________

- Interseed to improve diversity and abundance of nectar and/or milkweed species in existing stands of vegetation that have lost diversity.
  - Transmission Line ROW
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don’t Know
    - Barriers ____
  - Distribution Line ROW
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don’t Know
    - Barriers ____
  - Solar/Wind
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don’t Know
    - Barriers ____
  - Substations
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don’t Know
    - Barriers ____
  - Around Power Plants
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don’t Know
    - Barriers ____
  - Surplus Property
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don’t Know
    - Barriers ____

- Other Property Class/Type: [List]
  - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
  - Barriers ______________________________
  - Describe property class/type ______________________________

- Increase abundance of native milkweed and/or nectar species in seed mixes.
  - Transmission Line ROW
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ______________________________
  - Distribution Line ROW
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ______________________________
  - Solar/Wind
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ______________________________
  - Substations
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ______________________________
  - Around Power Plants
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ______________________________
  - Surplus Property
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ______________________________
  - Other Property Class/Type: [List]
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ______________________________
    - Describe property class/type ______________________________

- Irrigate for early plant establishment as needed (for example, in drought years, arid areas, for transplants, etc.).
  - Transmission Line ROW
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ______________________________
  - Distribution Line ROW
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ______________________________
  - Solar/Wind
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ______________________________
  - Substations
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ______________________________
  - Around Power Plants
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ______________________________
  - Surplus Property
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ______________________________
  - Other Property Class/Type: [List]
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ______________________________
    - Describe property class/type ______________________________
- Prioritize the use of locally (or regionally if local is unavailable) sourced native plant material.
  - Transmission Line ROW
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ______________________________

- Distribution Line ROW
  - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
  - Barriers ____
- Solar/Wind
  - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
  - Barriers ____
- Substations
  - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
  - Barriers ____
- Around Power Plants
  - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
  - Barriers ____
- Surplus Property
  - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
  - Barriers ____
- Other Property Class/Type: [List]
  - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
  - Barriers ____
  - Describe property class/type ________________________________

- Include spatial or vegetative buffers around areas with butterfly host plants or nectar sources. If using a vegetative buffer, ensure that it is not attractive to pollinators (for example, conifers).
  - Transmission Line ROW
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ____
  - Distribution Line ROW
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ____
  - Solar/Wind
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know

  - o Barriers ________________________________
- – Substations
  - o Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
  - o Barriers ________________________________
- – Around Power Plants
  - o Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
  - o Barriers ________________________________
- – Surplus Property
  - o Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
  - o Barriers ________________________________
- – Other Property Class/Type: [List]
  - o Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
  - o Barriers ________________________________
  - o Describe property class/type ________________________________

Herbicides

- Use herbicides within an integrated vegetation management (IVM) plan that specifically minimize impacts to pollinators, includes selecting the most effective and feasible invasive plant management method (for example, physical, mechanical, chemical).
  - – Transmission Line ROW
    - o Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - o Barriers ________________________________
  - – Distribution Line ROW
    - o Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - o Barriers ________________________________
  - – Solar/Wind
    - o Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - o Barriers ________________________________
  - – Substations
    - o Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - o Barriers ________________________________

- Around Power Plants
  - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
  - Barriers ______________________________
- Surplus Property
  - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
  - Barriers ______________________________
- Other Property Class/Type: [List]
  - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
  - Barriers ______________________________
  - Describe property class/type ______________________________

• Apply herbicides at the lowest effective application rate specified on the product label.

- Transmission Line ROW
  - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
  - Barriers ______________________________
- Distribution Line ROW
  - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
  - Barriers ______________________________
- Solar/Wind
  - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
  - Barriers ______________________________
- Substations
  - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
  - Barriers ______________________________
- Around Power Plants
  - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
  - Barriers ______________________________
- Surplus Property
  - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
  - Barriers ______________________________

- Other Property Class/Type: [List]
  - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
  - Barriers ______________________________
  - Describe property class/type ______________________________

- Use selective herbicides to reduce damage to non-target plants and avoid impacts to monarch-supporting vegetation.
  - Transmission Line ROW
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ______________________________
  - Distribution Line ROW
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ______________________________
  - Solar/Wind
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ______________________________
  - Substations
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ______________________________
  - Around Power Plants
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ______________________________
  - Surplus Property
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ______________________________
  - Other Property Class/Type: [List]
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ______________________________
    - Describe property class/type ______________________________

- Apply herbicides during plant life stages when target plants are most vulnerable (before blooming or going to seed).
  - Transmission Line ROW
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ______________________________
  - Distribution Line ROW
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ______________________________
  - Solar/Wind
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ______________________________
  - Substations
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ______________________________
  - Around Power Plants
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ______________________________
  - Surplus Property
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ______________________________
  - Other Property Class/Type: [List]
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ______________________________
    - Describe property class/type ______________________________
- Keep herbicide applications directed on target plants to avoid weakening non-target species such as targeting species using spot treatments (for example, using backpack sprayer, weed wiper, or directly onto cut stumps/under bark).
  - Transmission Line ROW
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ______________________________

- Distribution Line ROW
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ___
- Solar/Wind
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ___
- Substations
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ___
- Around Power Plants
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ___
- Surplus Property
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ___
- Other Property Class/Type: [List]
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ___
    - Describe property class/type ___

- Take precautions to avoid off-site movement of herbicides and reduce the risk of drift such as avoiding applications when wind speeds are over 15 mph or during temperature inversions, keeping equipment calibrated, and using the lowest effective pressure and largest droplet size possible.
    - Transmission Line ROW
        - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
        - Barriers ___
    - Distribution Line ROW
        - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
        - Barriers ___

- Solar/Wind
  - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
  - Barriers ____________________
- Substations
  - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
  - Barriers ____________________
- Around Power Plants
  - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
  - Barriers ____________________
- Surplus Property
  - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
  - Barriers ____________________
- Other Property Class/Type: [List]
  - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
  - Barriers ____________________
  - Describe property class/type ____________________

- Do not use aerial application of herbicides.
  - Transmission Line ROW
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ____________________
  - Distribution Line ROW
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ____________________
  - Solar/Wind
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ____________________
  - Substations
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ____________________

- Around Power Plants
  - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
  - Barriers ____
- Surplus Property
  - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
  - Barriers ____
- Other Property Class/Type: [List]
  - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
  - Barriers ____
  - Describe property class/type ______________________________

Create new monarch habitat

- Create new monarch habitat. Monarch habitat includes monarch-attractive nectar plants and/or native milkweeds.
  - Transmission Line ROW
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ____
  - Distribution Line ROW
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ____
  - Solar/Wind
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ____
  - Substations
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ____
  - Around Power Plants
    - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
    - Barriers ____

– Surplus Property

  - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don’t Know
  - Barriers ____

– Other Property Class/Type: [List]

  - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don’t Know
  - Barriers ____
  - Describe property class/type ____

COMMUNICATION/TRAINING OPPORTUNITIES

Rate the following communication opportunities for Extent Implemented across your company and provide a brief explanation of the barriers (for example, staff training, financial constraints, equipment limitations, incompatibility with other goals, staff resources, permit or legal limitations, etc.).

High = 70–100%, Moderate 40–69%, Low 5–39%, None <5%

- Engage the public about the importance of monarch conservation through interpretive signage at monarch habitat, online forums, social media posts, printed publications, workshops or events, etc. Include information on your website about steps your company is taking to support monarch habitat.
  - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
  - Barriers ____
- Communication/coordination with neighbors and landowners within ROW about pesticide use and habitat protection and management. For example, produce and distribute outreach materials; contact larger landowners via e-mail or phone about conserving monarch habitat.
  - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
  - Barriers ____
- Train staff and contractors in plant identification. The ability to recognize native plants, including milkweeds, as well as invasive plant species will reduce unintended damage to non-target plants.
  - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
  - Barriers ____
- Train staff and contractors on updates to your IVM and land management plans and practices to reduce harm to monarchs.
  - Extent Implemented: ☐ High ☐ Moderate ☐ Low ☐ None ☐ N/A, Don't Know
  - Barriers ____

FINAL QUESTIONS

If not already included in the survey responses above, please list federal and state laws and regulations that limit your ability to implement ecologically desirable monarch conservation actions. These could include FERC vegetation management requirements, substation vegetation mowing requirements, nuclear station clearance zones, etc. Please consider all your asset types in answering this question: solar, hydro, ROW, substations, surplus properties, etc.

Considering all the barriers and opportunities, in your opinion, which of your property types has the greatest meaningful potential to support monarch habitat with the lowest barriers? (Select up to 3).

- Solar Sites
- Wind Sites
- Transmission Lines
- Distribution Lines
- Power Plant Generation Sites (coal, nuclear, natural gas, hydro)
- Substations
- Surplus properties
- Other: [Fill in]
- **Please explain:** ______________________________

Please provide any other comments, perspectives, or concerns related to monarchs that you feel are important.

C
MONARCH CONSERVATION RESOURCES

Following are links to a small selection of resources related to monarch conservation and implementation. This list is not complete.

General Monarch Resources

- Monarch Joint Venture is a partnership of over 80 conservation, education, and research partners from across the United States. Their website contains hundreds of resources including handouts, FAQs, a monarch conservation webinar series, and the Monarch Conservation Implementation Plan (updated annually), which provides detailed information about and prioritization of conservation activities being undertaken by partners.
- The Xerces Society's monarch program includes resources such as monarch nectar plant guides, milkweed propagation and selection guides, and the comprehensive Pollinator Conservation Resource Center. Western-specific resources can be found on additional Xerces' websites: Western Monarch Thanksgiving Count (overwintering sites) and Western Monarch Milkweed Mapper (breeding and migratory habitat).
- U.S. Fish and Wildlife Service's Save the Monarch page contains many resources related to monarch conservation and USFWS work on the species conservation.
- MAFWA's webpage about monarchs includes the Mid-American Conservation Strategy 2018–2038.
- WAFWA's webpage includes the draft Western Monarch Butterfly Conservation Strategy 2018–2068.
- Many other agency and NGO websites contain more information about monarchs, including the Monarch Larva Monitoring Project, Monarch Net, Monarch Watch, Natural Resources Conservation Service, Pollinator Partnership, Project Monarch Health, Southwest Monarch Study, and US Forest Service.
- The University of Illinois at Chicago, Rights-of-way as Habitat Working Group, is coordinating an effort to develop a Candidate Conservation Agreement with Assurances to minimize organizational risk for future impacts to monarch, if the species receives federal protection status under the U.S. Endangered Species Act.

Select Milkweed and Nectar Plant Selection, Sourcing, and Propagation Resources

- The Native Plant Journal's propagation protocols for *Asclepias* spp.
- Xerces' Milkweed Seed Finder.
- Monarch Watch Milkweed Market Vendors.

- Xerces' Western Monarch Milkweed Mapper here.
- Ecoregional Revegetation Assistant Tool is a map-based tool to help practitioners to select native plants suitable for revegetation of a site by using filters for needed plant attributes, including value to pollinators.
- Interseeding Wildflowers to Diversify Grasslands.
- Regional Pollinator Habitat Installation Guides provide in-depth practical guidance on how to install and maintain nectar- and pollen-rich habitat for pollinators.

Select Technical and/or Financial Assistance Programs for Monarch Habitat Restoration

- USDA Natural Resource Conservation Services (for example, Conservation Stewardship Program, Environmental Quality Incentives Program). See Using Farm Bill Programs for Pollinator Conservation
- Working Lands For Wildlife Monarch Conservation Program by the USDA Natural Resources Conservation Service
- USDA Farm Service Agency (for example, Conservation Reserve Program)
- Partners for Fish and Wildlife Program by the U.S. Fish and Wildlife Service

The Electric Power Research Institute, Inc. (EPRI, www.epri.com) conducts research and development relating to the generation, delivery and use of electricity for the benefit of the public. An independent, nonprofit organization, EPRI brings together its scientists and engineers as well as experts from academia and industry to help address challenges in electricity, including reliability, efficiency, affordability, health, safety and the environment. EPRI also provides technology, policy and economic analyses to drive long-range research and development planning, and supports research in emerging technologies. EPRI members represent 90% of the electricity generated and delivered in the United States with international participation extending to 40 countries. EPRI's principal offices and laboratories are located in Palo Alto, Calif.; Charlotte, N.C.; Knoxville, Tenn.; Dallas, Texas; Lenox, Mass.; and Washington, D.C.

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